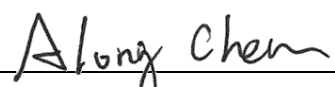


FCC Test Report

FCC ID : SQG-LWB5PLUS
Equipment : Sterling-LWB5+ 802.11a/b/g/n/ac Module with Bluetooth 5.0
Model No. : Sterling LWB5+
Brand Name : Laird Connectivity
Applicant : Laird Connectivity
Address : W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA
Standard : 47 CFR FCC Part 15.247
Received Date : Jun. 11, 2020
Tested Date : Jul. 31 ~ Aug. 31, 2020

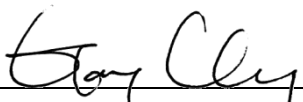
We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:



Along Chen / Assistant Manager

Approved by:



Gary Chang / Manager



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Release Record

Report No.	Version	Description	Issued Date
FR061103AD	Rev. 01	Initial issue	Nov. 10, 2020

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	Conducted Emissions	[dBuV]: 4.454MHz 49.89 (Margin -6.11dB) - QP	Pass
15.247(d) 15.209	Radiated Emissions	[dBuV/m at 3m]: 6.53MHz 36.22 (Margin -3.78dB) - PK	Pass
15.247(d)	Band Edge	Meet the requirement of limit	Pass
15.247(b)(1)	Conducted Output Power	Power [dBm]: 8.83	Pass
15.247(a)(1)(iii)	Number of Hopping Channels	Meet the requirement of limit	Pass
15.247(a)(1)	Hopping Channel Separation	Meet the requirement of limit	Pass
15.247(a)(1)(iii)	Dwell Time	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Product Details

The device has 5 configurations as below:

Brand name	Model Name	Product Name	Part Number	Description
Laird Connectivity	Sterling LWB5+	Sterling-LWB5+ 802.11a/b/g/n/ac Module with Bluetooth 5.0	453-00045	Chip Antenna
Laird Connectivity	Sterling LWB5+	Sterling-LWB5+ 802.11a/b/g/n/ac Module with Bluetooth 5.0	453-00046	MHF4 Connector
Laird Connectivity	Sterling LWB5+	Sterling-LWB5+ 802.11a/b/g/n/ac Module with Bluetooth 5.0	453-00047	RF Trace Pin
Laird Connectivity	Sterling LWB5+	Sterling-LWB5+ 802.11a/b/g/n/ac Module with Bluetooth 5.0	453-00048	M.2 PCI-E Card w/SDIO and UART Interface
Laird Connectivity	Sterling LWB5+	Sterling-LWB5+ 802.11a/b/g/n/ac Module with Bluetooth 5.0	453-00049	M.2 PCI-E Card w/USB and USB Interface
+ Part Number: 453-00046 was selected as a representative one for the final test				

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	Bluetooth Mode	Ch. Frequency (MHz)	Channel Number	Data Rate
2400-2483.5	BR	2402-2480	0-78 [79]	1 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	2 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	3 Mbps
Note 1: RF output power specifies that Maximum Peak Conducted Output Power. Note 2: Bluetooth BR uses a GFSK. Note 3: Bluetooth EDR uses a combination of $\pi/4$-DQPSK and 8DPSK.				

1.1.3 Antenna Details

Ant. No.	Manufacturer	Model	Laird Part Number	Type	Connector	Antenna Gain (dBi)
1	Laird	2.4/5.5 GHz Dipole Antenna	001-0009	Dipole	RP-SMA	2.0
2	Laird	FlexPIFA	001-0021	PIFA	IPEX MHF4L	2.5
3	Laird	Mini NanoBlade Flex	EMF2449A1-10MH4L	PCB Dipole	IPEX MHF4L	2.79
4	Laird	Nanoblade	ENB2449A1-10MH4L	PCB Dipole	IPEX MHF4L	2.0
5	ACX	AD1608-A2455AAT/LF	NA	Chip Antenna	N/A	1.0

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	3.3 Vdc
-------------------	---------

1.1.5 Accessories

N/A

1.1.6 Channel List

Frequency band (MHz)				2400~2483.5			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461	---	---

1.1.7 Test Tool and Duty Cycle

Test Tool	Bluetool, Version: 1.9.8.6	
Modulation Mode	Duty Cycle Of Test Signal (%)	Duty Factor (dB)
DH5	78.94%	1.03
3DH5	79.07%	1.02

1.1.8 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)		
	2402	2441	2480
GFSK/1Mbps	8	8	8
$\pi/4$ -DQPSK /2Mbps	12	12	12
8DPSK/3Mbps	12	12	12

1.2 Local Support Equipment List

Support Equipment List (Part Number: 453-00046_ SDIO)					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Carrier Board	Laird	DVK-LWB5+	---	Provided by applicant.
2	Fixture	Laird	SU60-SOMC	---	Provided by applicant.
3	DC Cable	ICC	DCC-10m-R	---	---
4	DC Cable	ICC	DCC-10m-B	---	---
5	Notebook	DELL	Latitude E6430	---	---
6	DC Power Supply	GWINSTEK	GPC-60300	---	---
7	50Ω terminator	---	---	---	---

Support Equipment List (Part Number: 453-00046_ USB)					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Carrier Board	Laird	DVK-LWB5+	---	Provided by applicant.
2	DC Power Supply	GWINSTEK	GPC-60300	---	Provided by applicant.
3	USB Cable	I-Gota	micro to A	---	---
4	Notebook	DELL	Latitude E6430	---	---
5	50Ω terminator	---	---	---	---

Support Equipment List (Part Number: 453-00048_ SDIO)

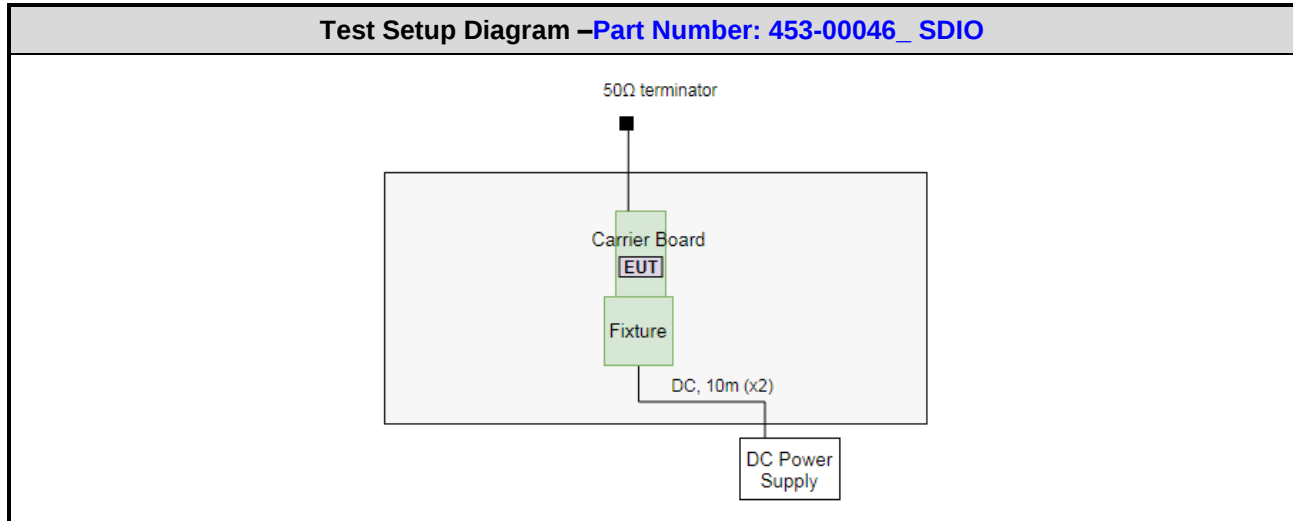
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Carrier Board	Laird	LWB5+,M.2	---	Provided by applicant.
2	Fixture	Laird	SU60-SOMC	---	Provided by applicant.
3	DC Cable	ICC	DCC-10m-R	---	---
4	DC Cable	ICC	DCC-10m-B	---	---
5	Notebook	DELL	Latitude E6430	---	---
6	DC Power Supply	GWINSTEK	GPC-60300	---	---
7	50Ω terminator	---	---	---	---

Support Equipment List (Part Number: 453-00049_ USB)

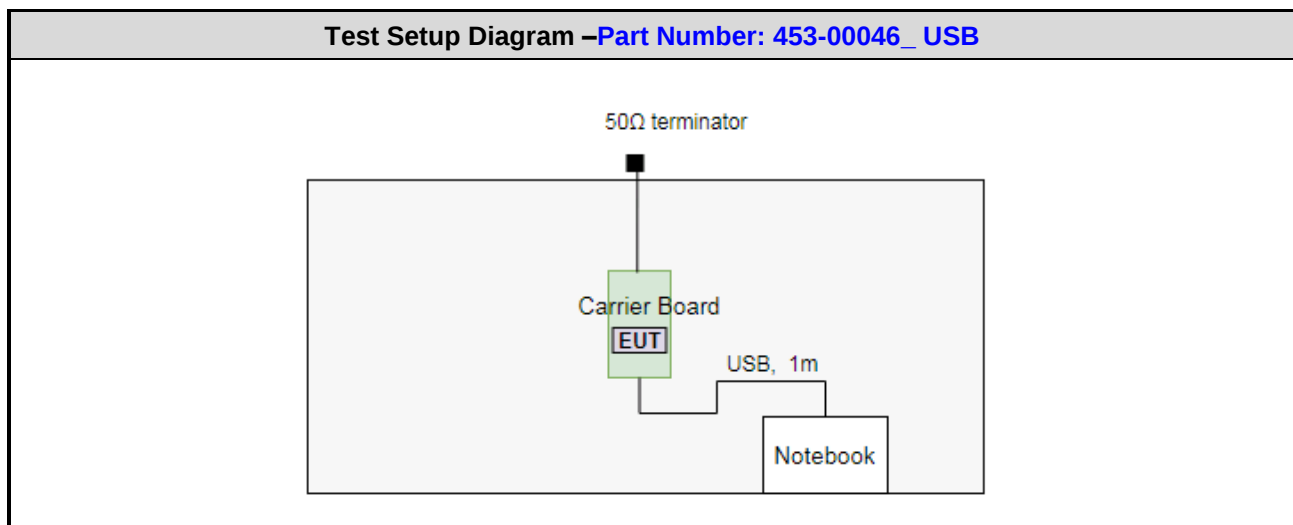
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Carrier Board	Laird	LWB5+,M.2	---	Provided by applicant.
2	DC Power Supply	GWINSTEK	GPC-60300	---	Provided by applicant.
3	USB Cable	I-Gota	micro to A	---	---
4	Notebook	DELL	Latitude E6430	---	---
5	50Ω terminator	---	---	---	---

1.3 Test Setup Chart

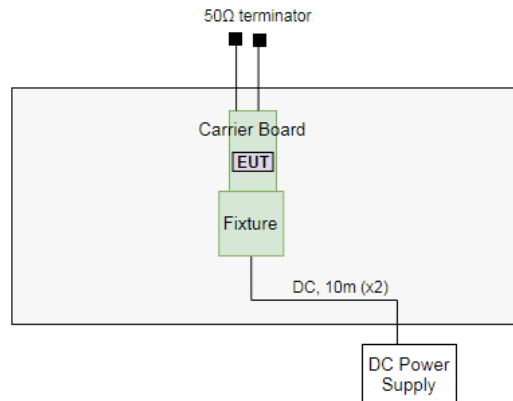
For radiated emission



Note: The notebook is disconnected from EUT and removed from test table when EUT is set to transmit continuously.

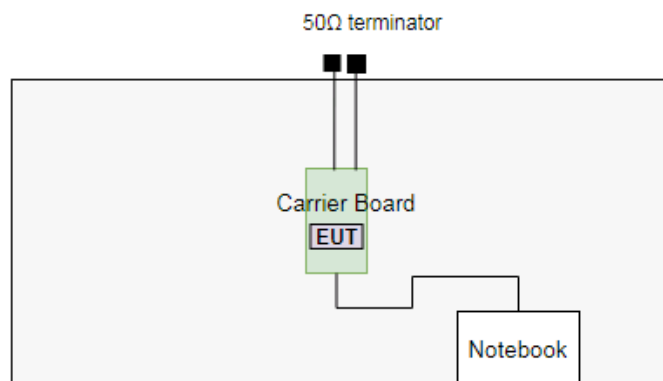


Test Setup Diagram –Part Number: 453-00048_ SDIO



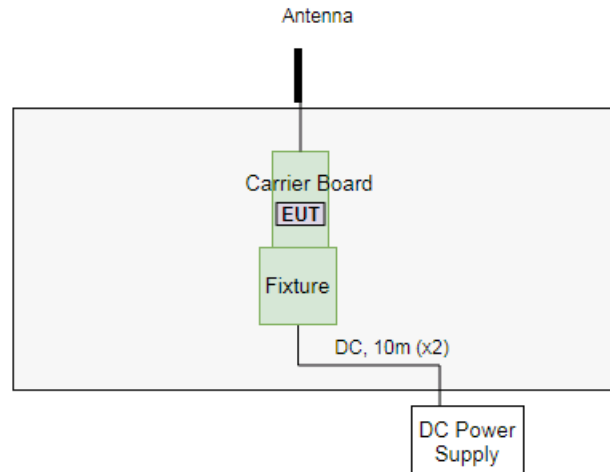
Note: The notebook is disconnected from EUT and removed from test table when EUT is set to transmit continuously.

Test Setup Diagram –Part Number: 453-00049_ USB



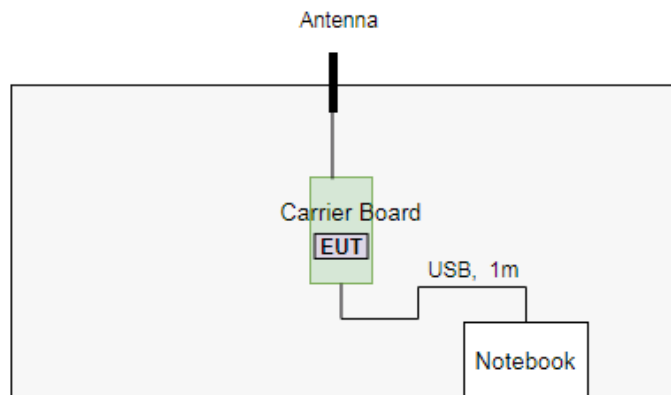
For conducted emission

Test Setup Diagram –Part Number: 453-00046_ SDIO

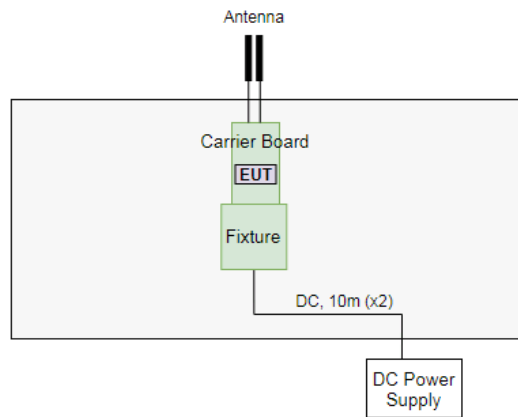


Note: The notebook is disconnected from EUT and removed from test table when EUT is set to transmit continuously.

Test Setup Diagram –Part Number: 453-00046_ USB

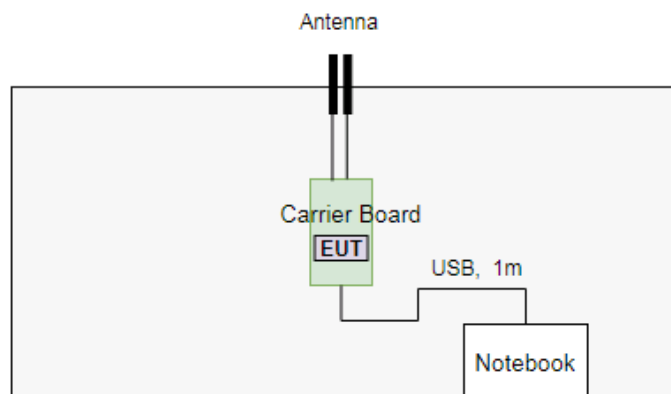


Test Setup Diagram –Part Number: 453-00048_ SDIO



Note: The notebook is disconnected from EUT and removed from test table when EUT is set to transmit continuously.

Test Setup Diagram –Part Number: 453-00049_ USB



1.4 Test Equipment List and Calibration Data

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Test Date	Aug. 18, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Dec. 12, 2019	Dec. 11, 2020
LISN	R&S	ENV216	101579	Mar. 12, 2020	Mar. 11, 2021
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 22, 2019	Oct. 21, 2020
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Test Date	Jul. 31 ~ Aug. 11, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Dec. 17, 2019	Dec. 16, 2020
Receiver	R&S	ESR3	101657	Feb. 14, 2020	Feb. 13, 2021
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Jul. 10, 2020	Jul. 09, 2021
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 12, 2019	Dec. 11, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2019	Nov. 14, 2020
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2019	Nov. 12, 2020
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 07, 2019	Oct. 06, 2020
Preamplifier	EMC	EMC02325	980225	Jul. 03, 2020	Jul. 02, 2021
Preamplifier	Agilent	83017A	MY39501308	Oct. 08, 2019	Oct. 07, 2020
Preamplifier	EMC	EMC184045B	980192	Jul. 21, 2020	Jul. 20, 2021
RF Cable	EMC	EMC104-SM-SM-8000	181106	Oct. 07, 2019	Oct. 06, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Oct. 07, 2019	Oct. 06, 2020
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Oct. 07, 2019	Oct. 06, 2020
LF cable 1M	EMC	EMCCFD400-NM-NM-1000	160502	Oct. 07, 2019	Oct. 06, 2020
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Oct. 07, 2019	Oct. 06, 2020
LF cable 10M	EMC	CFD400-E	CFD400-001	Oct. 18, 2019	Oct. 17, 2020
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Test Date	Jul. 31 ~ Aug. 31, 2020				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101063	Apr. 30, 2020	Apr. 29, 2021
Power Meter	Anritsu	ML2495A	1241002	Oct. 23, 2019	Oct. 22, 2020
Power Sensor	Anritsu	MA2411B	1207366	Oct. 23, 2019	Oct. 22, 2020
DC POWER SOURCE	GW INSTEK	GPC-6030D	GES855395	Oct. 29, 2019	Oct. 28, 2020
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

47 CFR FCC Part 15.247

ANSI C63.10-2013

1.6 Reference Guidance

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$)).

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	± 34.130 Hz
Conducted power	± 0.808 dB
Power density	± 0.583 dB
Conducted emission	± 2.715 dB
AC conducted emission	± 2.92 dB
Radiated emission ≤ 1 GHz	± 3.41 dB
Radiated emission > 1 GHz	± 4.59 dB
Time	$\pm 0.1\%$

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corp.
Test Site	CO01-WS, 03CH01-WS, TH01-WS
Address of Test Site	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- ISED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Data Rate (Mbps)	Test Configuration
Conducted Emissions Radiated Emissions $\leq$ 1GHz	GFSK	2402	1Mbps	1, 2, 3, 4
Radiated Emissions > 1GHz	GFSK 8DPSK	2402, 2441, 2480	1Mbps 3Mbps	1
	GFSK 8DPSK	2402	1Mbps 3Mbps	3
Conducted Output Power	GFSK	2402, 2441, 2480	1Mbps	1, 3
	11/4 DQPSK	2402, 2441, 2480	2Mbps	
	8DPSK	2402, 2441, 2480	3Mbps	
Number of Hopping Channels	GFSK	2402~2480	1Mbps	1
	11/4 DQPSK	2402~2480	2Mbps	
	8DPSK	2402~2480	3Mbps	
Hopping Channel Separation 20dB and Occupied bandwidth	GFSK	2402, 2441, 2480	1Mbps	1
	11/4 DQPSK	2402, 2441, 2480	2Mbps	
	8DPSK	2402, 2441, 2480	3Mbps	
Dwell Time	GFSK	2441	1Mbps	1
	11/4 DQPSK	2441	2Mbps	
	8DPSK	2441	3Mbps	

NOTE:

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Z-plane** results were found as the worst case and were shown in this report.
- Test configurations are as below
 Configuration 1: Part Number: 453-00046(SDIO) with PCB Dipole Antenna
 Configuration 2: Part Number: 453-00046(USB) with PCB Dipole Antenna
 Configuration 3: Part Number: 453-00048 with PCB Dipole Antenna
 Configuration 4: Part Number: 453-00049 with PCB Dipole Antenna
- 50 Ω terminator was connected to antenna port of EUT for radiated emission measurement.
- Test antenna port of configuration 3 is worst antenna port found after pretest.

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

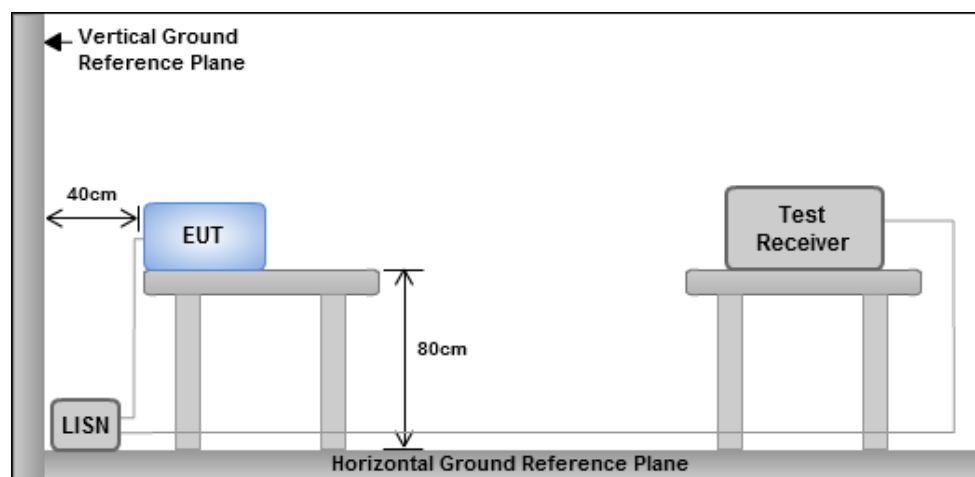
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V/60Hz

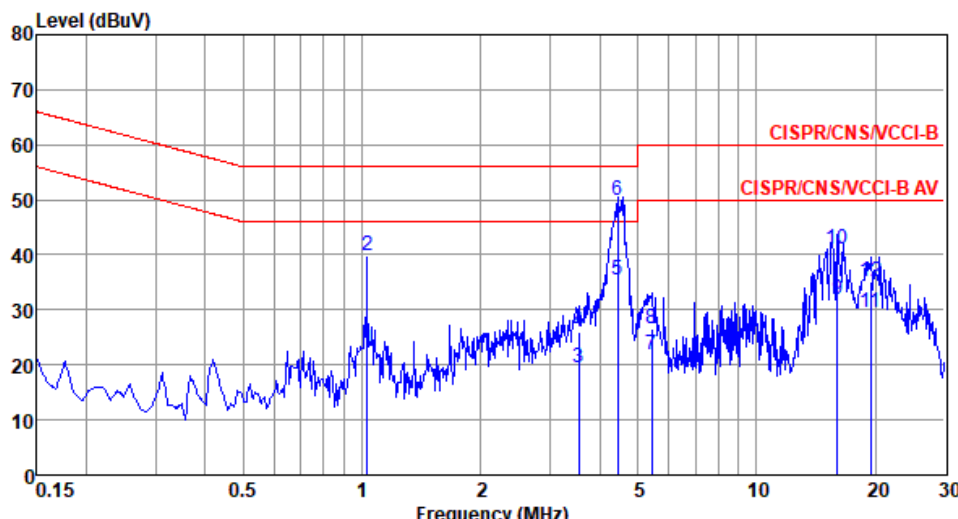
3.1.3 Test Setup



- Note: 1. Support units were connected to second LISN.
 2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

3.1.4 Test Result of Conducted Emissions

Configuration 1

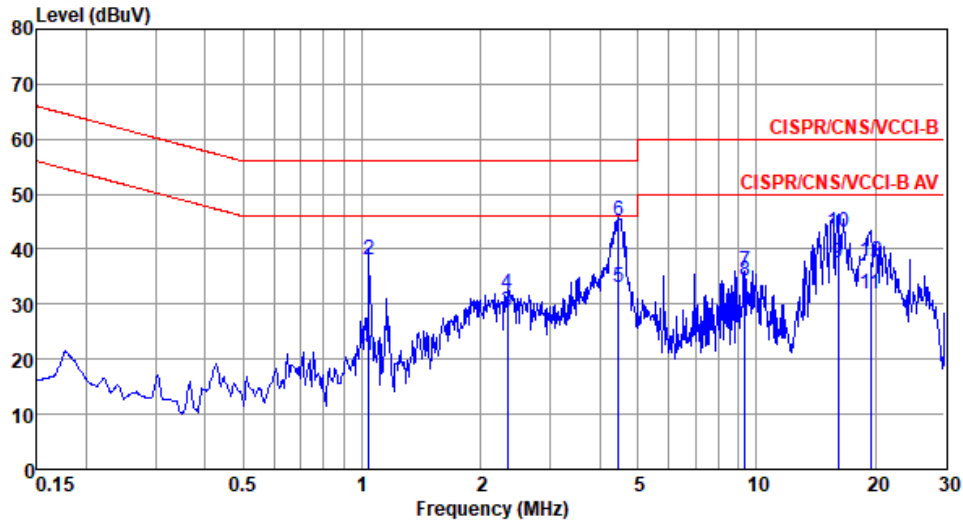
Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																					
Power Phase	Line																																																																																																																							
Test by : Alex Tsai Temperature: 24°C Humidity: 60%																																																																																																																								
Level (dBuV)  Frequency (MHz) <table><tr><th></th><th>Freq MHz</th><th>Level dBuV</th><th>Limit Line dBuV</th><th>Over Limit dB</th><th>Read Level dBuV</th><th>LISN factor dB</th><th>cable loss dB</th><th>Remark</th></tr><tr><td>1</td><td>1.032</td><td>22.73</td><td>46.00</td><td>-23.27</td><td>12.98</td><td>9.63</td><td>0.12</td><td>Average</td></tr><tr><td>2</td><td>1.032</td><td>39.76</td><td>56.00</td><td>-16.24</td><td>30.01</td><td>9.63</td><td>0.12</td><td>QP</td></tr><tr><td>3</td><td>3.547</td><td>19.52</td><td>46.00</td><td>-26.48</td><td>9.60</td><td>9.65</td><td>0.27</td><td>Average</td></tr><tr><td>4</td><td>3.547</td><td>25.87</td><td>56.00</td><td>-30.13</td><td>15.95</td><td>9.65</td><td>0.27</td><td>QP</td></tr><tr><td>5</td><td>4.454</td><td>35.31</td><td>46.00</td><td>-10.69</td><td>25.36</td><td>9.65</td><td>0.30</td><td>Average</td></tr><tr><td>6*</td><td>4.454</td><td>49.89</td><td>56.00</td><td>-6.11</td><td>39.94</td><td>9.65</td><td>0.30</td><td>QP</td></tr><tr><td>7</td><td>5.419</td><td>21.81</td><td>50.00</td><td>-28.19</td><td>11.83</td><td>9.66</td><td>0.32</td><td>Average</td></tr><tr><td>8</td><td>5.419</td><td>26.53</td><td>60.00</td><td>-33.47</td><td>16.55</td><td>9.66</td><td>0.32</td><td>QP</td></tr><tr><td>9</td><td>16.055</td><td>31.91</td><td>50.00</td><td>-18.09</td><td>21.59</td><td>9.71</td><td>0.61</td><td>Average</td></tr><tr><td>10</td><td>16.055</td><td>40.95</td><td>60.00</td><td>-19.05</td><td>30.63</td><td>9.71</td><td>0.61</td><td>QP</td></tr><tr><td>11</td><td>19.428</td><td>29.51</td><td>50.00</td><td>-20.49</td><td>19.14</td><td>9.72</td><td>0.65</td><td>Average</td></tr><tr><td>12</td><td>19.428</td><td>35.28</td><td>60.00</td><td>-24.72</td><td>24.91</td><td>9.72</td><td>0.65</td><td>QP</td></tr></table>					Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark	1	1.032	22.73	46.00	-23.27	12.98	9.63	0.12	Average	2	1.032	39.76	56.00	-16.24	30.01	9.63	0.12	QP	3	3.547	19.52	46.00	-26.48	9.60	9.65	0.27	Average	4	3.547	25.87	56.00	-30.13	15.95	9.65	0.27	QP	5	4.454	35.31	46.00	-10.69	25.36	9.65	0.30	Average	6*	4.454	49.89	56.00	-6.11	39.94	9.65	0.30	QP	7	5.419	21.81	50.00	-28.19	11.83	9.66	0.32	Average	8	5.419	26.53	60.00	-33.47	16.55	9.66	0.32	QP	9	16.055	31.91	50.00	-18.09	21.59	9.71	0.61	Average	10	16.055	40.95	60.00	-19.05	30.63	9.71	0.61	QP	11	19.428	29.51	50.00	-20.49	19.14	9.72	0.65	Average	12	19.428	35.28	60.00	-24.72	24.91	9.72	0.65	QP
	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark																																																																																																																
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Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB). 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).																																																																																																																								

Modulation Mode	GFSK	Test Freq. (MHz)	2402
Power Phase	Neutral		

Test by : Alex Tsai

Temperature: 24°C

Humidity: 60%

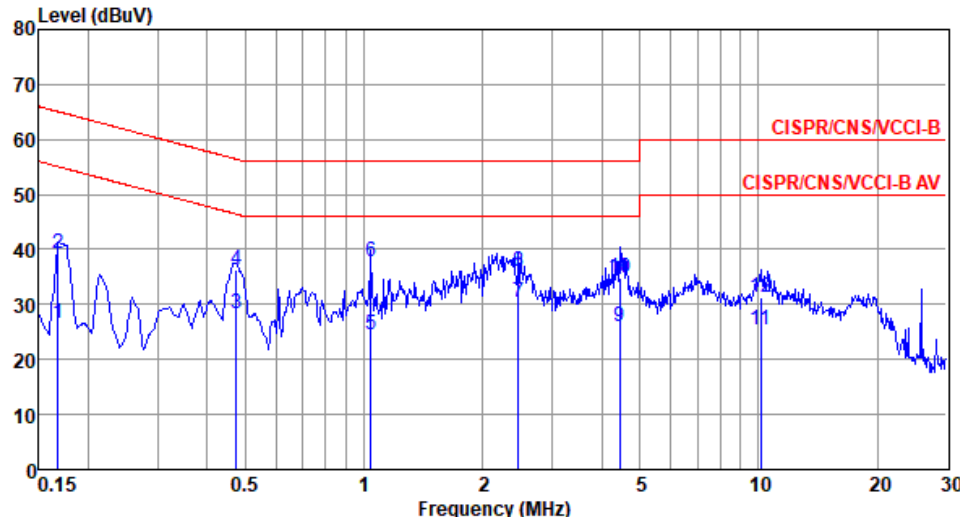


	Freq	Level	Limit	Over	Read	LISN	cable	
	MHz	dBuV	Line	Limit	Level	factor	loss	Remark
			dBuV	dB	dBuV	dB	dB	
1	1.043	20.79	46.00	-25.21	11.02	9.65	0.12	Average
2	1.043	38.16	56.00	-17.84	28.39	9.65	0.12	QP
3	2.334	28.51	46.00	-17.49	18.65	9.66	0.20	Average
4	2.334	31.90	56.00	-24.10	22.04	9.66	0.20	QP
5	4.478	32.98	46.00	-13.02	23.00	9.68	0.30	Average
6*	4.478	45.09	56.00	-10.91	35.11	9.68	0.30	QP
7	9.352	36.02	50.00	-13.98	25.91	9.73	0.38	Average
8	9.352	34.38	60.00	-25.62	24.27	9.73	0.38	QP
9	16.140	37.63	50.00	-12.37	27.20	9.81	0.62	Average
10	16.140	43.01	60.00	-16.99	32.58	9.81	0.62	QP
11	19.428	31.96	50.00	-18.04	21.47	9.84	0.65	Average
12	19.428	37.88	60.00	-22.12	27.39	9.84	0.65	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).
 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Configuration 2

Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																					
Power Phase	Line																																																																																																																							
Test by : Alex Tsai Temperature: 24°C Humidity: 60%																																																																																																																								
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	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark																																																																																																																
1	0.177	27.54	54.64	-27.10	17.85	9.63	0.06	Average																																																																																																																
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10	4.407	30.16	56.00	-25.84	20.21	9.65	0.30	QP																																																																																																																
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Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																					
Power Phase	Neutral																																																																																																																							
Test by : Alex Tsai Temperature: 24°C Humidity: 60%																																																																																																																								
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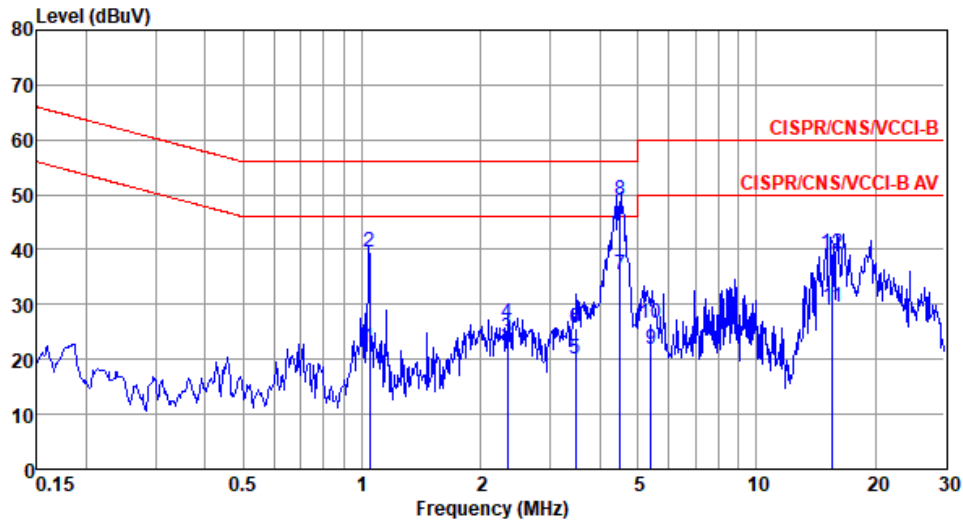
Configuration 3

Modulation Mode	GFSK	Test Freq. (MHz)	2402
Power Phase	Line		

Test by : Alex Tsai

Temperature: 24°C

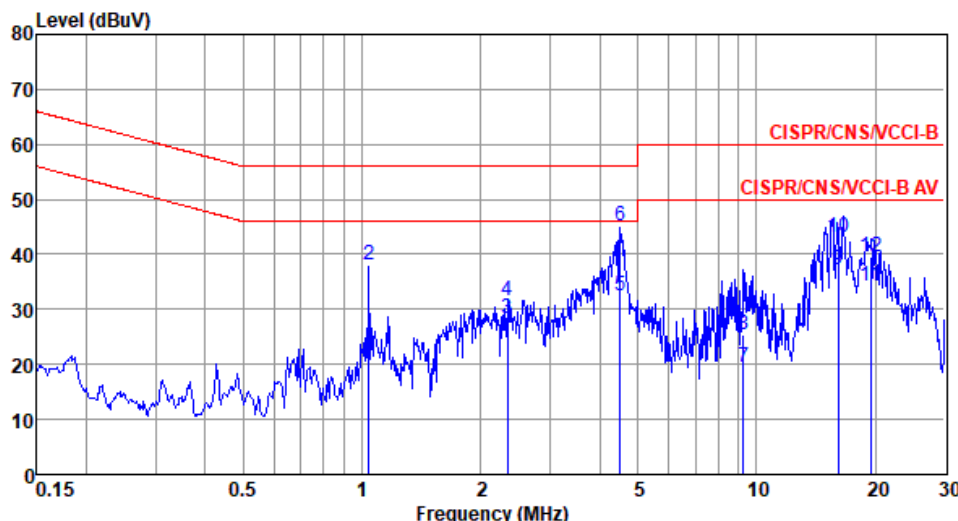
Humidity: 60%



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	1.048	22.05	46.00	-23.95	12.30	9.63	0.12	Average
2	1.048	39.44	56.00	-16.56	29.69	9.63	0.12	QP
3	2.339	24.01	46.00	-21.99	14.17	9.64	0.20	Average
4	2.339	26.52	56.00	-29.48	16.68	9.64	0.20	QP
5	3.482	20.05	46.00	-25.95	10.13	9.65	0.27	Average
6	3.482	25.63	56.00	-30.37	15.71	9.65	0.27	QP
7	4.516	35.40	46.00	-10.60	25.44	9.66	0.30	Average
8*	4.516	49.13	56.00	-6.87	39.17	9.66	0.30	QP
9	5.405	21.83	50.00	-28.17	11.85	9.66	0.32	Average
10	5.405	26.45	60.00	-33.55	16.47	9.66	0.32	QP
11	15.580	29.52	50.00	-20.48	19.20	9.71	0.61	Average
12	15.580	39.39	60.00	-20.61	29.07	9.71	0.61	QP

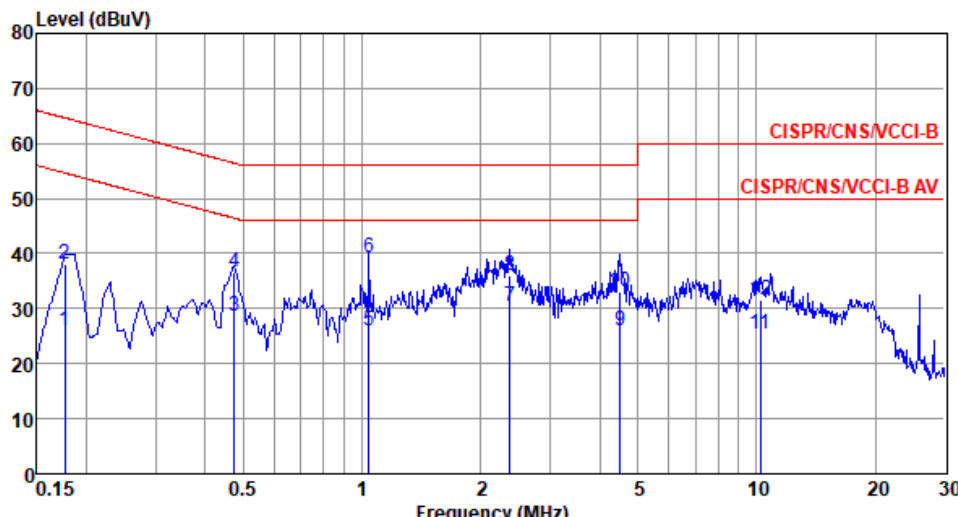
Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).

2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																								
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Configuration 4

Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																					
Power Phase	Line																																																																																																																							
Test by : Alex Tsai Temperature: 24°C Humidity: 60%																																																																																																																								
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3.2 Unwanted Emissions into Restricted Frequency Bands

3.2.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:
Qusai-Peak value is measured for frequency below 1GHz except for 9~90 kHz, 110~490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

Note 2:
Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.2.2 Test Procedures

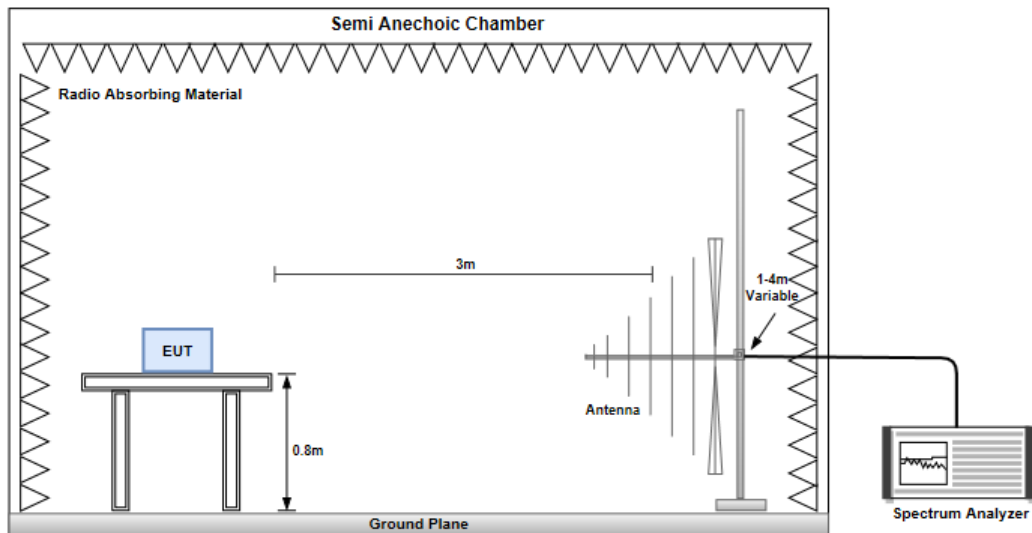
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

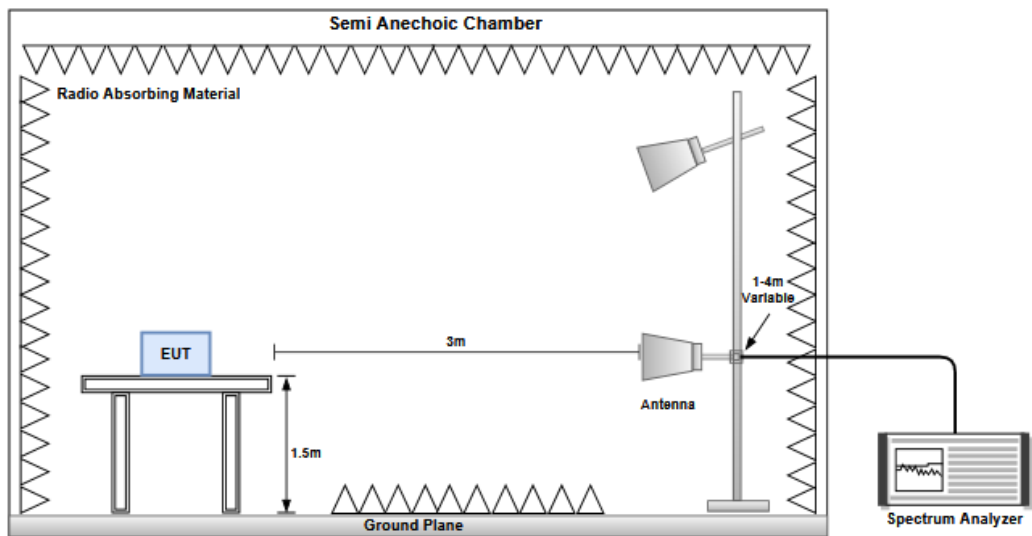
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. Radiated emission above 1GHz / Peak value
RBW=1MHz, VBW=3MHz and Peak detector
Radiated emission above 1GHz / Average value for harmonics
The average value is: Average = Peak value + 20log(Duty cycle) Where the duty factor is calculated from following formula for DH5 packet type which has worst duty factor:
3.
$$20\log (\text{Duty cycle}) = 20\log \frac{1\text{s} / 1600 * 5}{100 \text{ ms}} = -30.1\text{dB}$$
4. Radiated emission above 1GHz / Average value for other emissions
RBW=1MHz, VBW=1/T and Peak detector

3.2.3 Test Setup

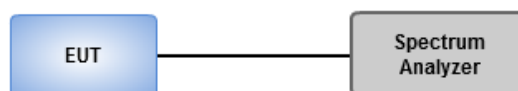
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



Transmitter Conducted Unwanted Emissions (30MHz~25GHz)



Configuration 1

3.2.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):23 Humidity(%):64			
Level (dBuV/m)			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):23 Humidity(%):64			
Level (dBuV/m)			

3.2.5 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

Modulation	GFSK		Test Freq. (MHz)		2402	
Polarization	Horizontal					
Test By :BRAD WU Temperature(°C):24 Humidity(%):63						
Level (dBUV/m) <						

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m) <			

Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

Modulation	GFSK	Test Freq. (MHz)	2441
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

Modulation	GFSK	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

3.2.6 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 8DPSK

Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m)			

Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

Modulation	8DPSK	Test Freq. (MHz)	2441
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m) </			

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m)			

Modulation	8DPSK	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m)			

Configuration 2

3.2.7 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):64			
Level (dBUV/m)			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):64			
Level (dBUV/m)			

Configuration 3

3.2.8 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):23 Humidity(%):64			
Level (dBuV/m)			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):23 Humidity(%):64			
Level (dBuV/m)			

3.2.9 Transmitter Radiated Unwanted Emissions (Above 1GHz) for GFSK

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m)			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m) <			

3.2.10 Transmitter Radiated Unwanted Emissions (Above 1GHz) for 8DPSK

Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m)			

Modulation	8DPSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m)			

Configuration 4

3.2.11 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):23 Humidity(%):64			
Level (dBuV/m)			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):23 Humidity(%):64			
Level (dBUV/m)			

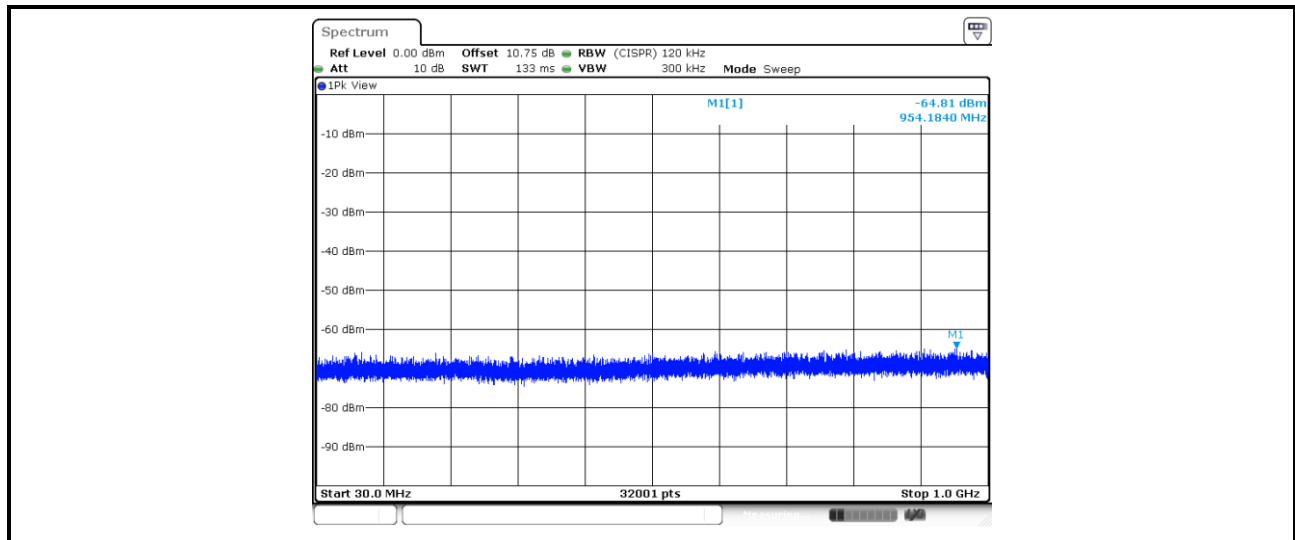
3.2.12 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

Configuration 1

Modulation Mode		8DPSK		Frequency		2402MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000	-64.81	2.79	4.70	-57.32	37.94	40.00	-2.06

Note:

1. GRF = Ground Reflection Factor.
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.

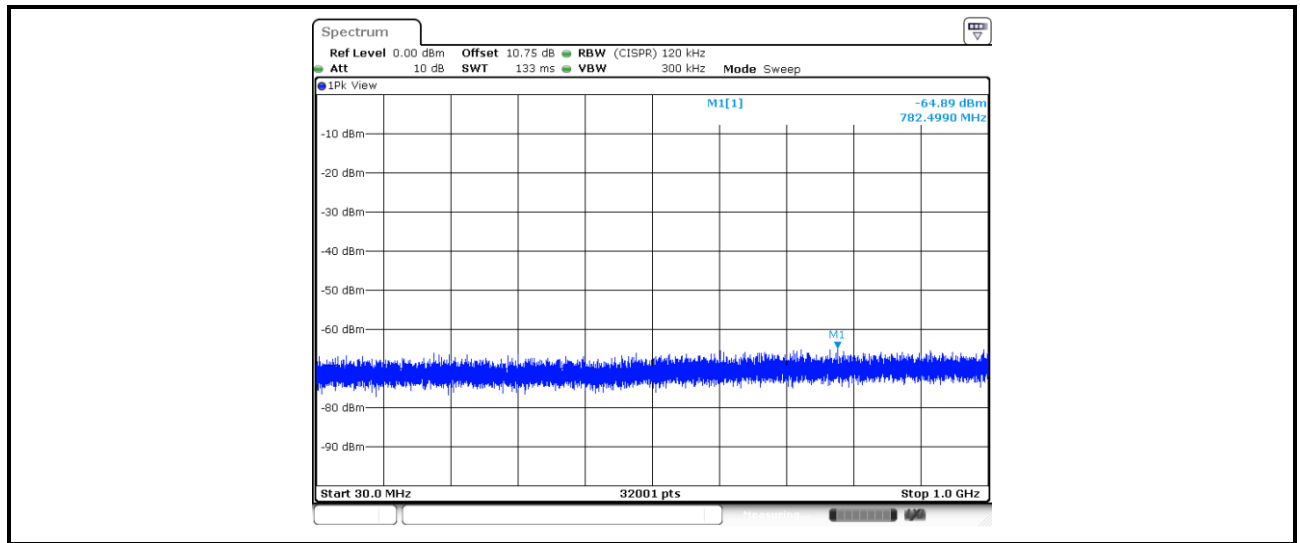


Configuration 2

Modulation Mode		8DPSK		Frequency		2402MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000	-64.89	2.79	4.70	-57.40	37.86	40.00	-2.14

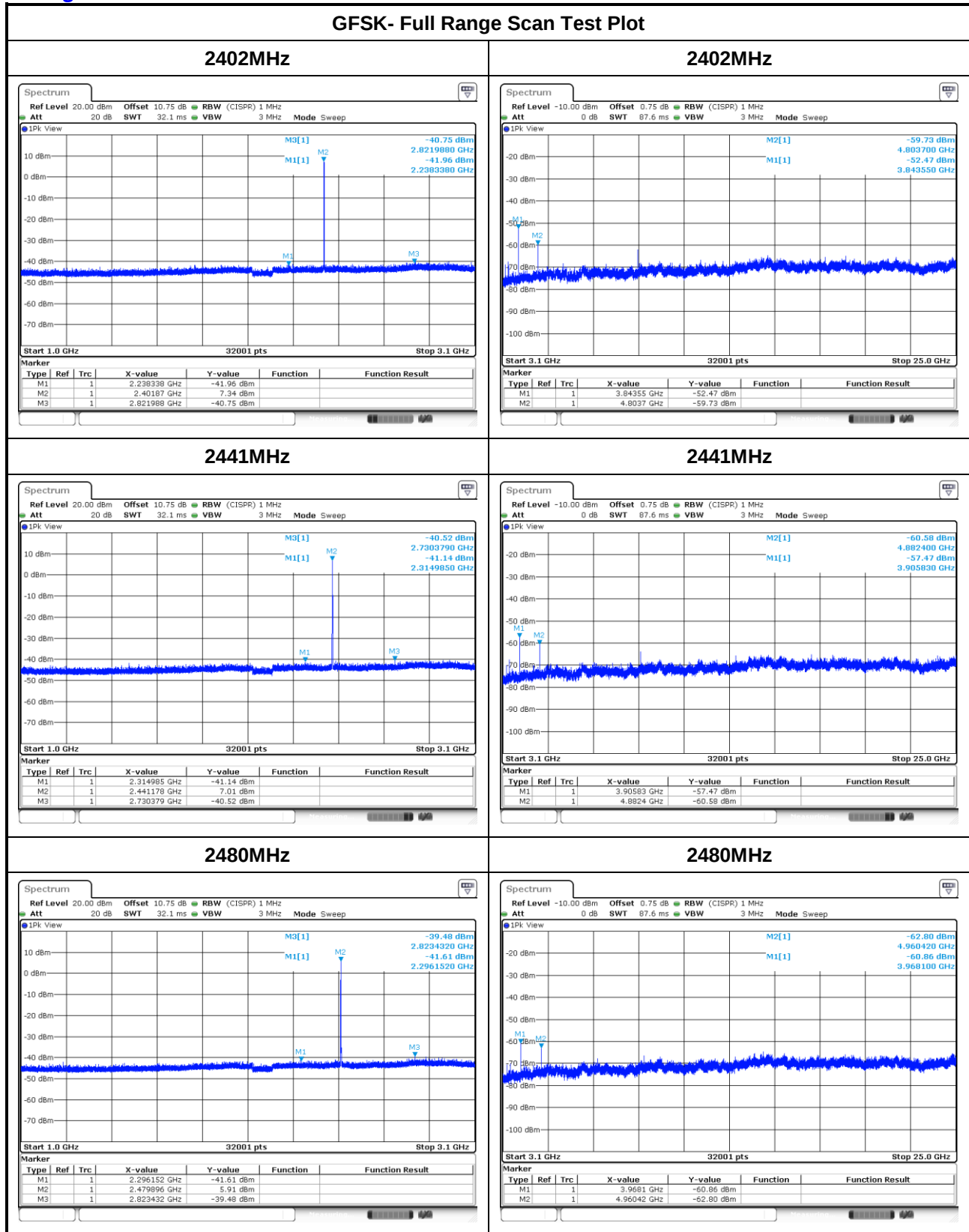
Note:

4. GRF = Ground Reflection Factor.
5. DG = Directional Gain.
6. Worst case of emission limit below 1GHz is selected to be limit.



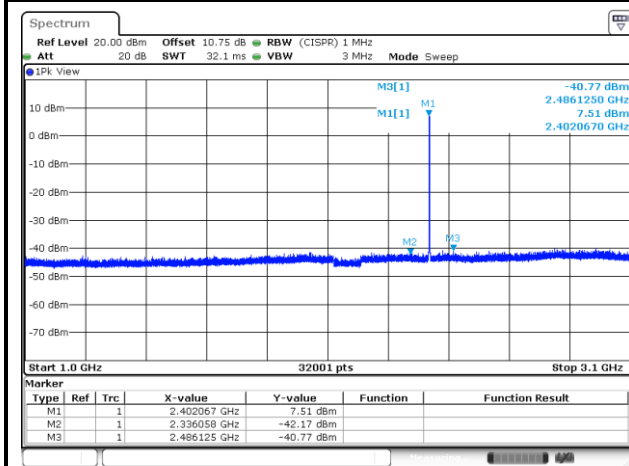
3.2.13 Transmitter Conducted Unwanted Emissions (Above 1GHz)

Configuration 1

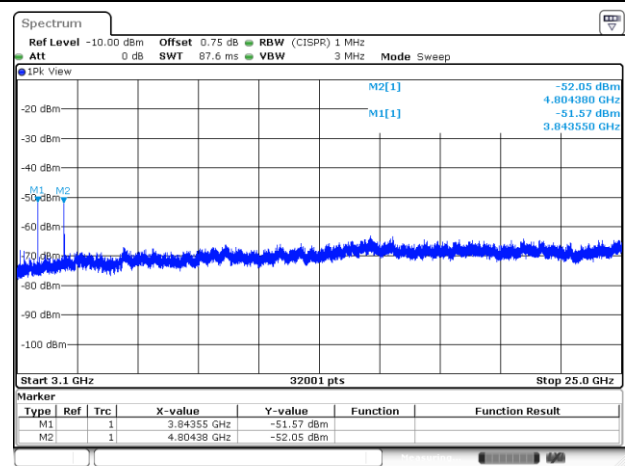


8DPSK- Full Range Scan Test Plot

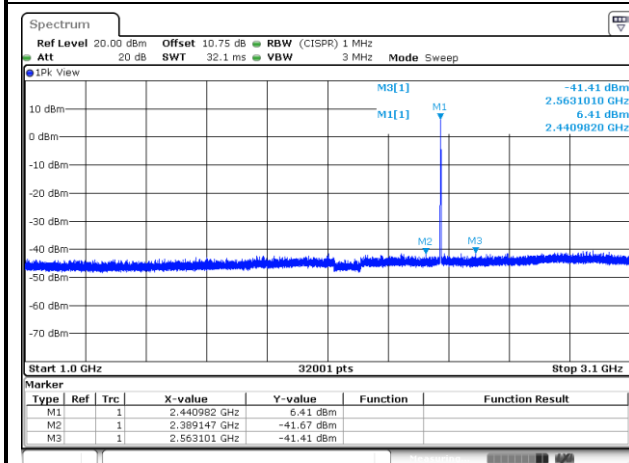
2402MHz



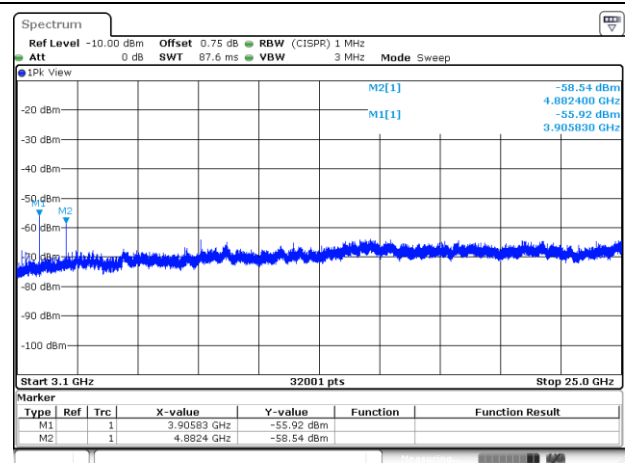
2402MHz



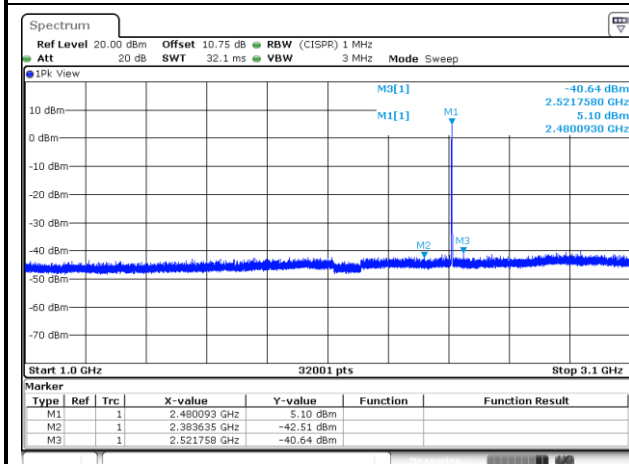
2441MHz



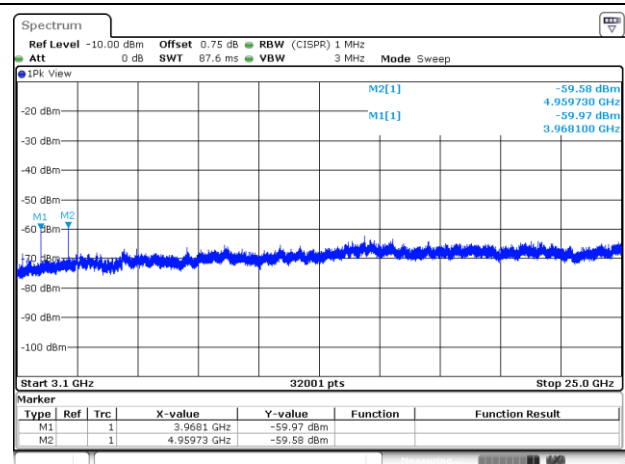
2441MHz



2480MHz

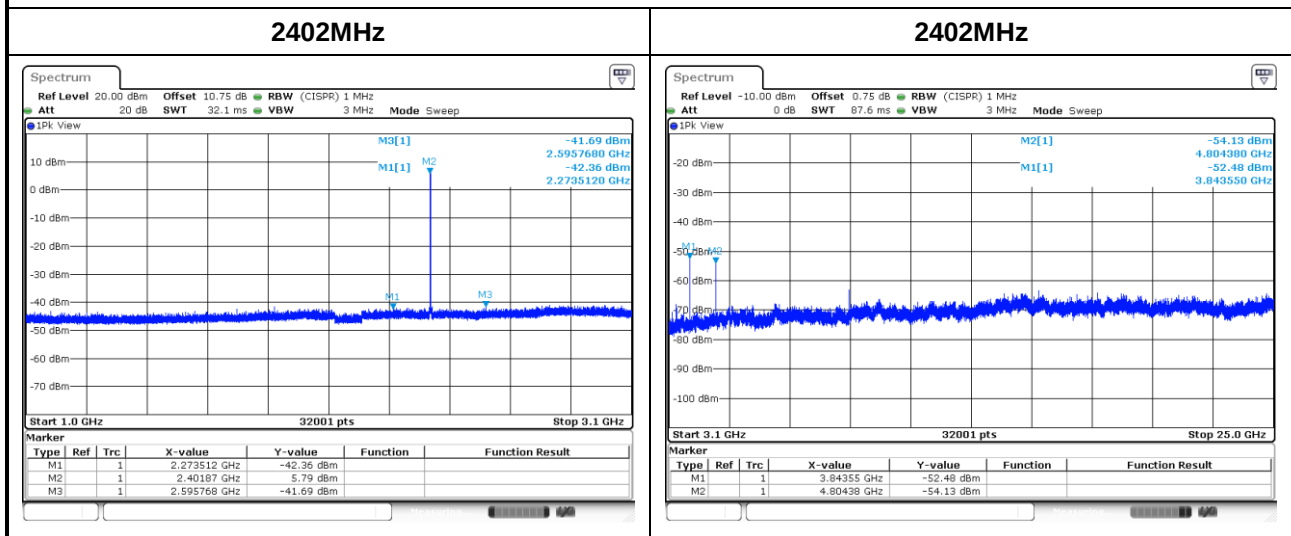


2480MHz

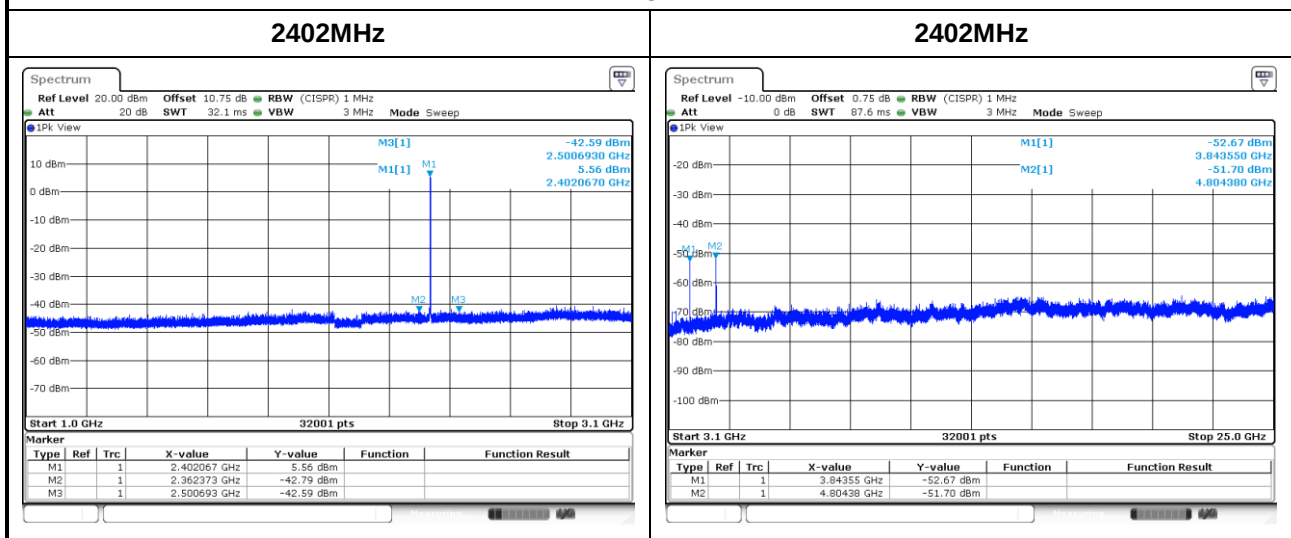


Configuration 3

GFSK- Full Range Scan Test Plot



8DPSK- Full Range Scan Test Plot



Configuration 1

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		GFSK						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-40.94	2.79	-38.15	57.11	74.00	-16.89	PK
	2310~2390	-54.69	2.79	-51.90	43.36	54.00	-10.64	AV
	2483.5~2500	-41.33	2.79	-38.54	56.72	74.00	-17.28	PK
	2483.5~2500	-54.76	2.79	-51.97	43.29	54.00	-10.71	AV
2441	2310~2390	-43.55	2.79	-40.76	54.50	74.00	-19.50	PK
	2310~2390	-57.25	2.79	-54.46	40.80	54.00	-13.20	AV
	2483.5~2500	-42.96	2.79	-40.17	55.09	74.00	-18.91	PK
	2483.5~2500	-56.93	2.79	-54.14	41.12	54.00	-12.88	AV
2480	2310~2390	-43.47	2.79	-40.68	54.58	74.00	-19.42	PK
	2310~2390	-56.60	2.79	-53.81	41.45	54.00	-12.55	AV
	2485.5~2500	-43.80	2.79	-41.01	54.25	74.00	-19.75	PK
	2483.5~2500	-56.24	2.79	-53.45	41.81	54.00	-12.19	AV

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		8DPSK						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-41.79	2.79	-39.00	56.26	74.00	-17.74	PK
	2310~2390	-55.37	2.79	-52.58	42.68	54.00	-11.32	AV
	2483.5~2500	-41.66	2.79	-38.87	56.39	74.00	-17.61	PK
	2483.5~2500	-54.98	2.79	-52.19	43.07	54.00	-10.93	AV
2441	2310~2390	-42.20	2.79	-39.41	55.85	74.00	-18.15	PK
	2310~2390	-55.47	2.79	-52.68	42.58	54.00	-11.42	AV
	2483.5~2500	-42.48	2.79	-39.69	55.57	74.00	-18.43	PK
	2483.5~2500	-55.02	2.79	-52.23	43.03	54.00	-10.97	AV
2480	2310~2390	-42.76	2.79	-39.97	55.29	74.00	-18.71	PK
	2310~2390	-55.76	2.79	-52.97	42.29	54.00	-11.71	AV
	2485.5~2500	-41.90	2.79	-39.11	56.15	74.00	-17.85	PK
	2483.5~2500	-54.98	2.79	-52.19	43.07	54.00	-10.93	AV

Note: DG = Directional Gain.

Configuration 3

Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		GFSK						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-42.01	2.79	-39.22	56.04	74.00	-17.96	PK
	2310~2390	-55.56	2.79	-52.77	42.49	54.00	-11.51	AV
	2483.5~2500	-41.92	2.79	-39.13	56.13	74.00	-17.87	PK
	2483.5~2500	-55.28	2.79	-52.49	42.77	54.00	-11.23	AV

Note: DG = Directional Gain.

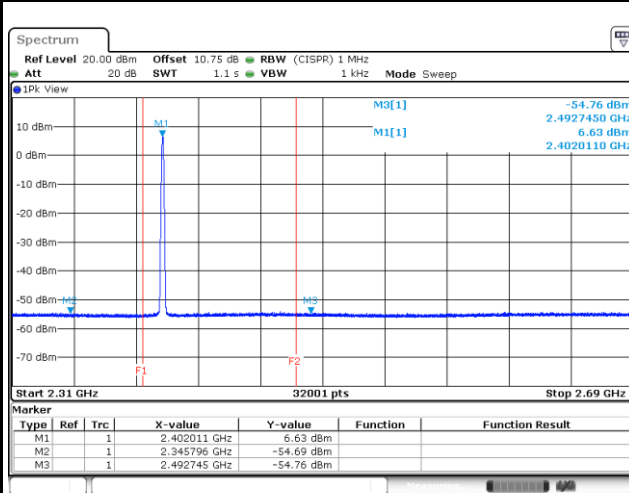
Transmitter Conducted Unwanted Emissions Results in Band Edge								
Modulation Mode		8DPSK						
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-42.45	2.79	-39.66	55.60	74.00	-18.40	PK
	2310~2390	-55.84	2.79	-53.05	42.21	54.00	-11.79	AV
	2483.5~2500	-42.71	2.79	-39.92	55.34	74.00	-18.66	PK
	2483.5~2500	-55.32	2.79	-52.53	42.73	54.00	-11.27	AV

Note: DG = Directional Gain.

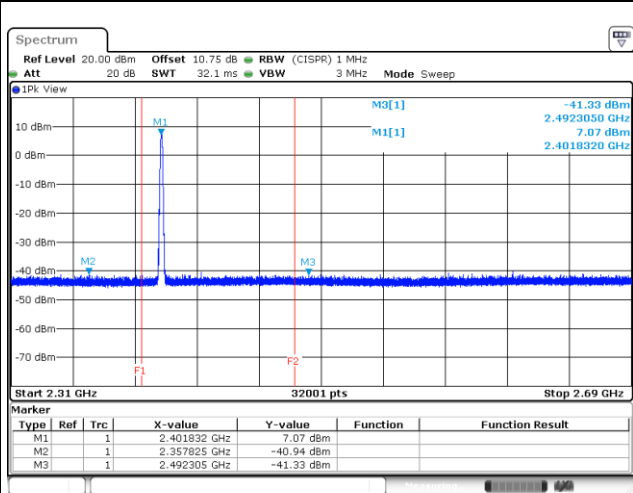
Configuration 1

GFSK_Band Edge Test Plot - BT EDR

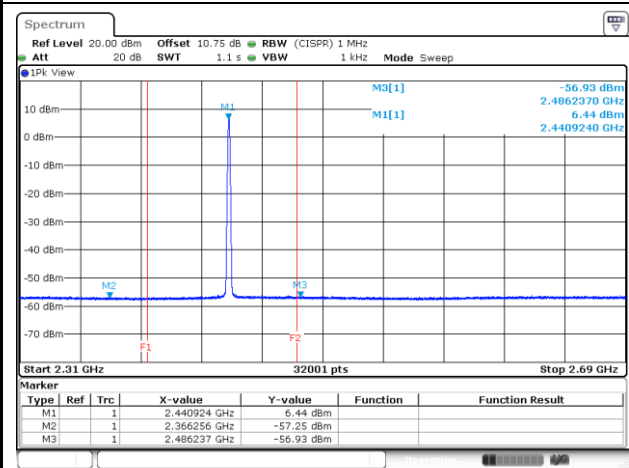
2402MHz - AV



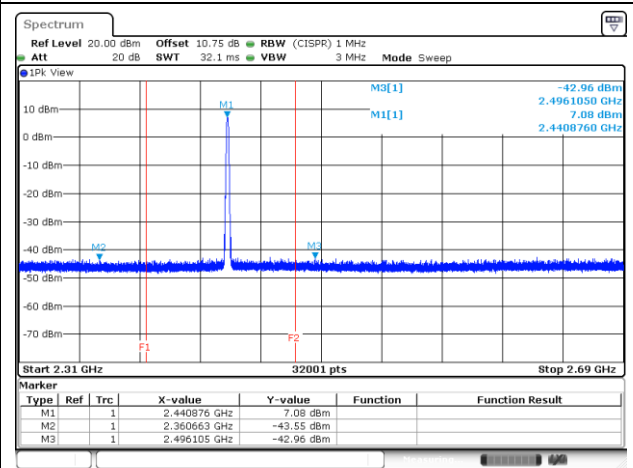
2402MHz - PK



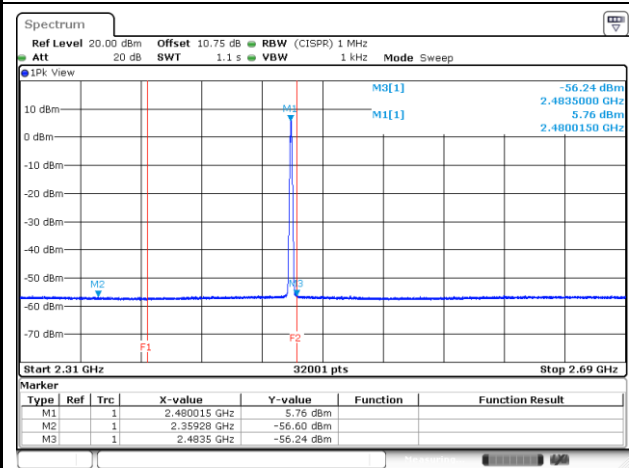
2441MHz - AV



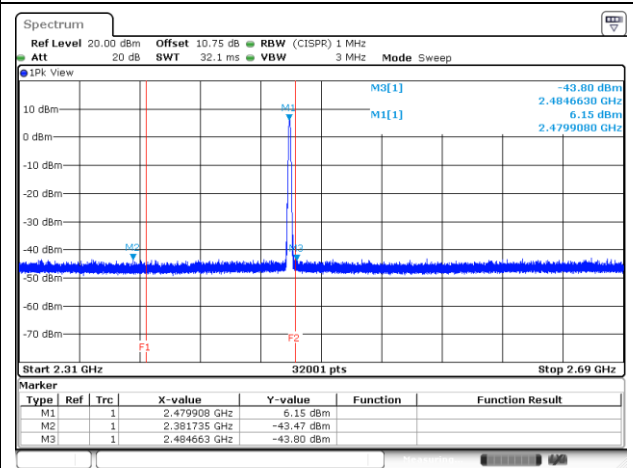
2441MHz - PK



2480MHz - AV

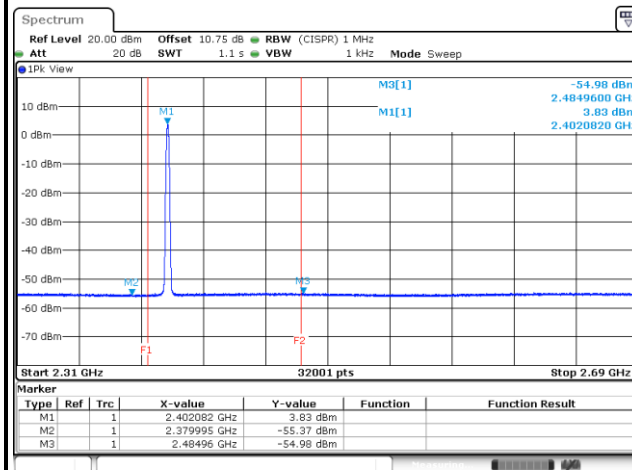


2480MHz - PK

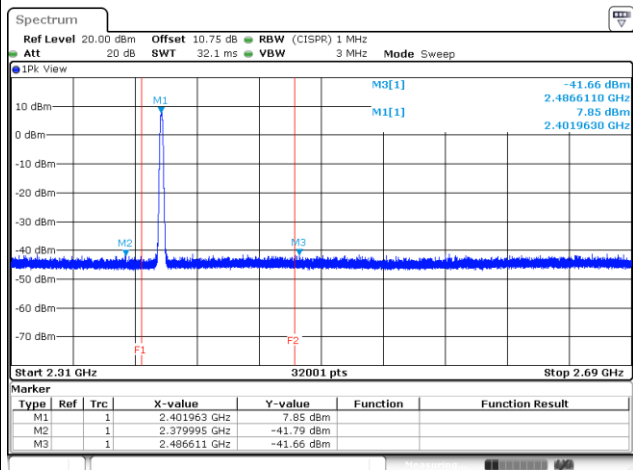


8DPSK_Band Edge Test Plot - BT EDR

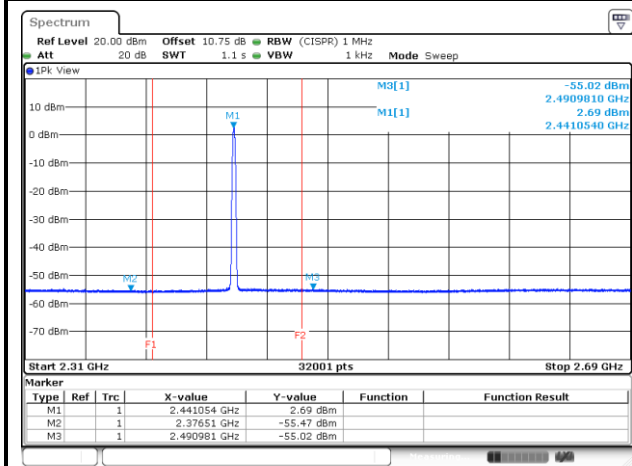
2402MHz - AV



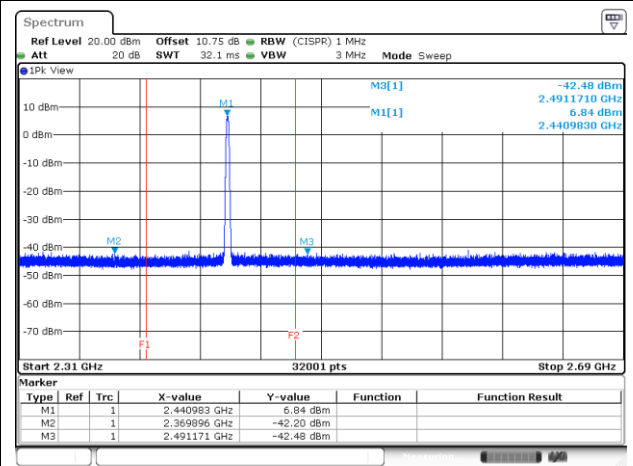
2402MHz - PK



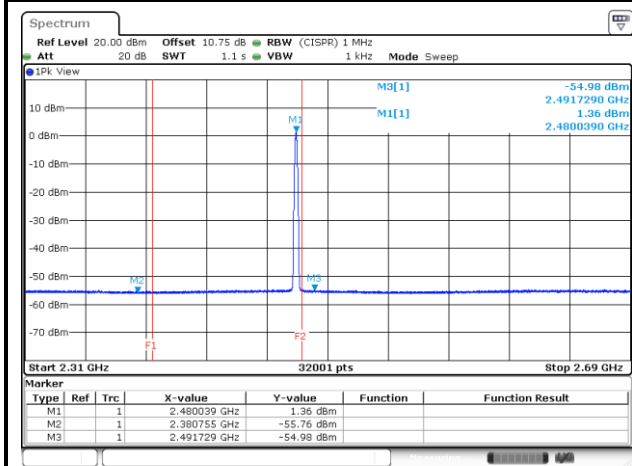
2441MHz - AV



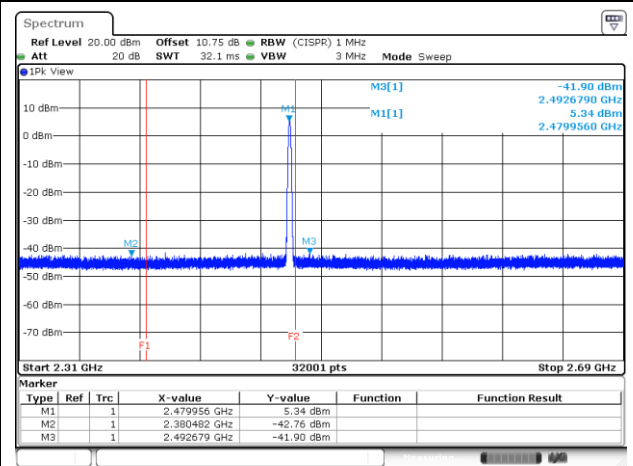
2441MHz - PK



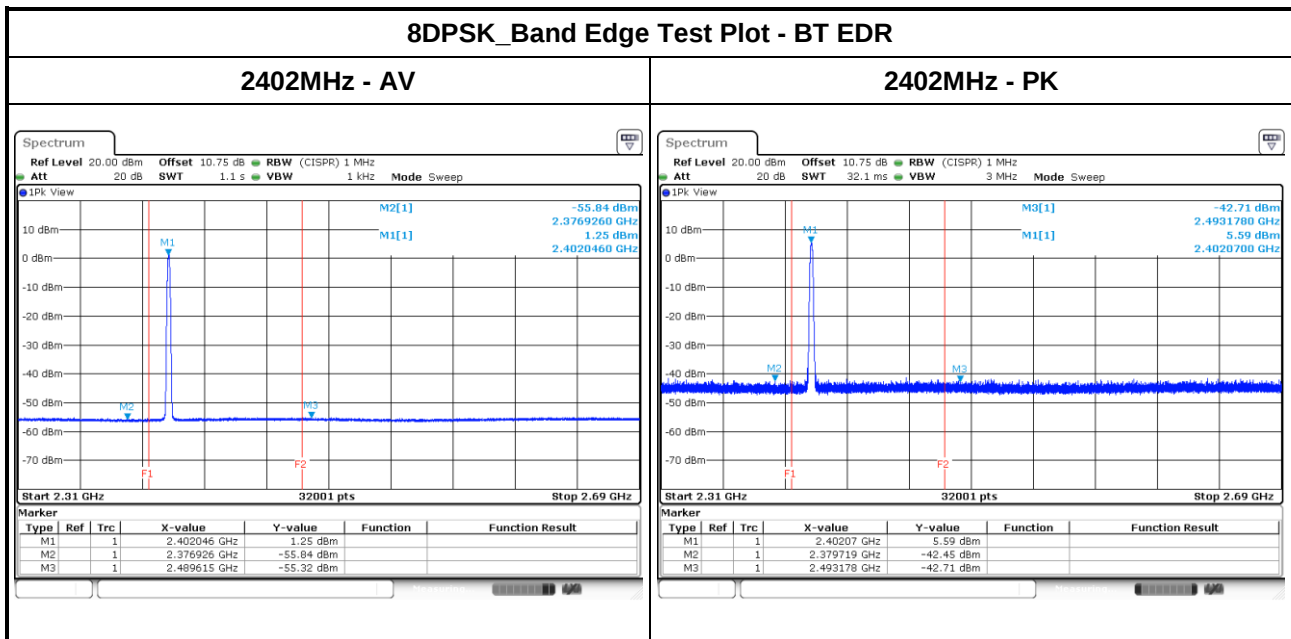
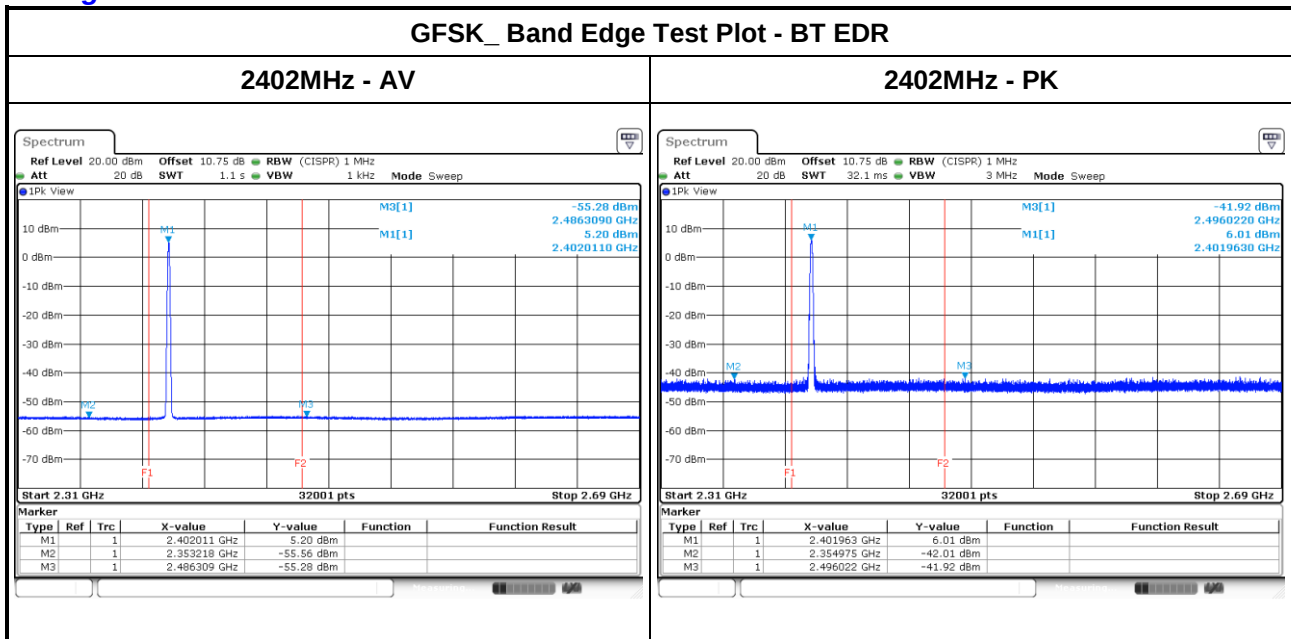
2480MHz - AV



2480MHz - PK



Configuration 3



Configuration 1

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3843.20	PK	-50.96	2.79	-48.17	47.09	74.00	-26.91
4804.00	PK	-52.32	2.79	-49.53	45.73	74.00	-28.27

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2441MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3905.60	PK	-55.22	2.79	-52.43	42.83	74.00	-31.17
4882.00	PK	-58.17	2.79	-55.38	39.88	74.00	-34.12

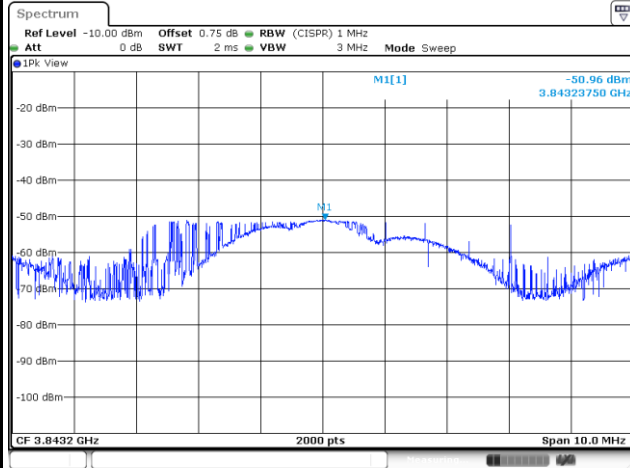
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3968.00	PK	-58.78	2.79	-55.99	39.27	74.00	-34.73
4960.00	PK	-60.92	2.79	-58.13	37.13	74.00	-36.87

Note:

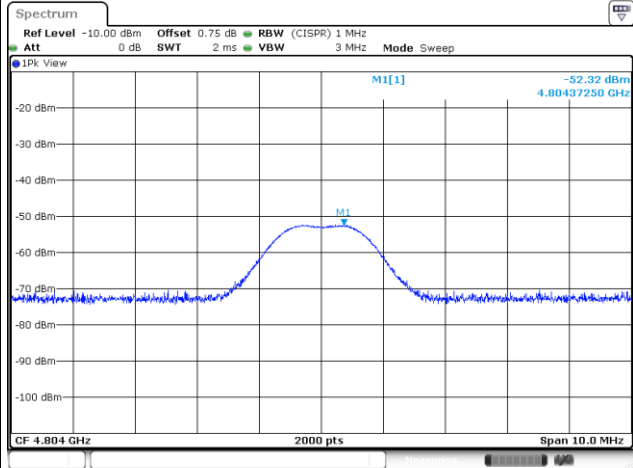
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

GFSK_Test Plots

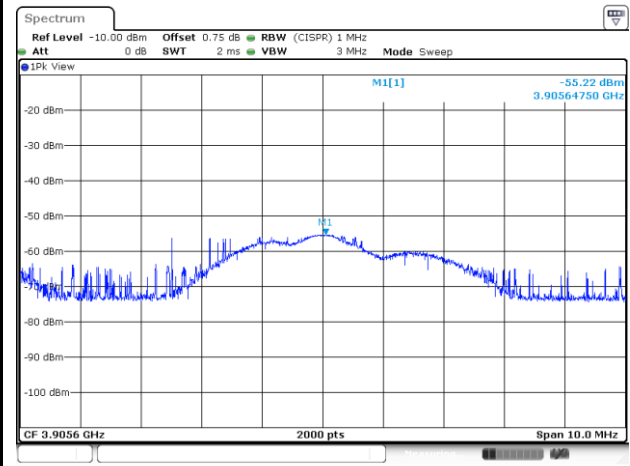
2402MHz - PK



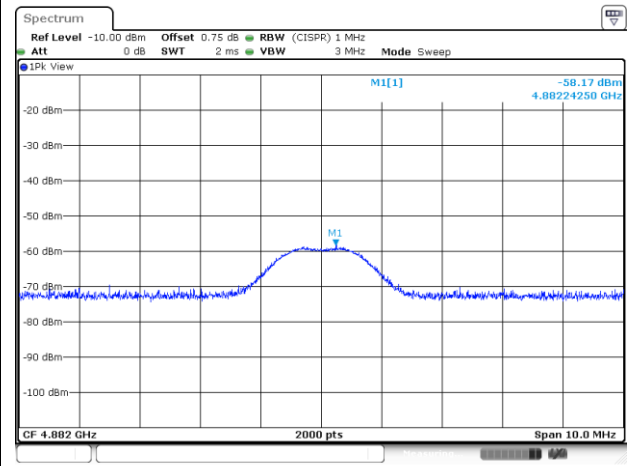
2402MHz - PK



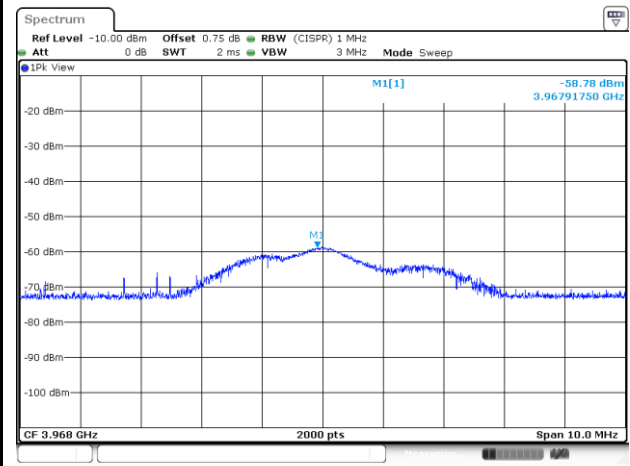
2441MHz - PK



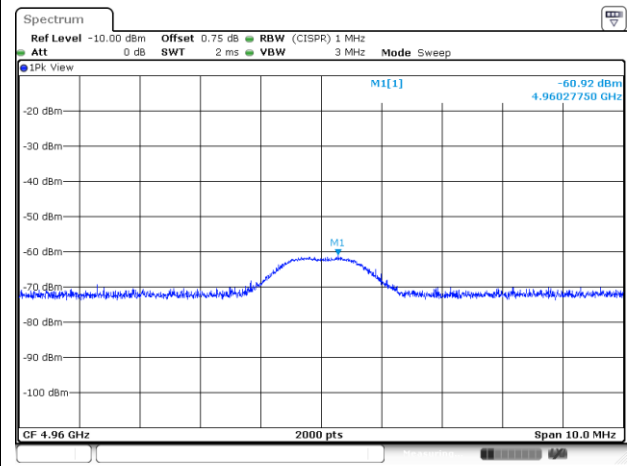
2441MHz - PK



2480MHz - PK



2480MHz - PK



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3843.20	PK	-49.28	2.79	-46.49	48.77	74.00	-25.23
4804.00	PK	-50.70	2.79	-47.91	47.35	74.00	-26.65

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2441MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3905.60	PK	-53.65	2.79	-50.86	44.40	74.00	-29.60
4882.00	PK	-57.10	2.79	-54.31	40.95	74.00	-33.05

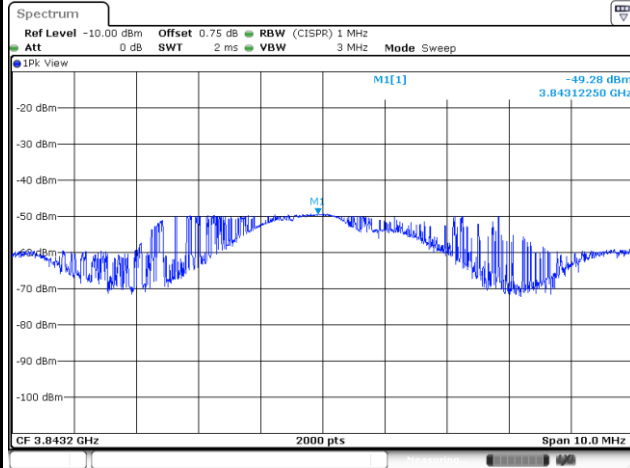
Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2480MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3968.00	PK	-57.98	2.79	-55.19	40.07	74.00	-33.93
4960.00	PK	-58.02	2.79	-55.23	40.03	74.00	-33.97

Note:

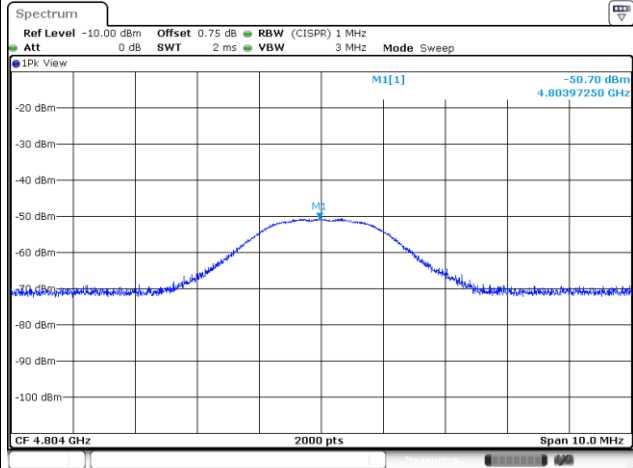
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

8DPSK_Test Plots

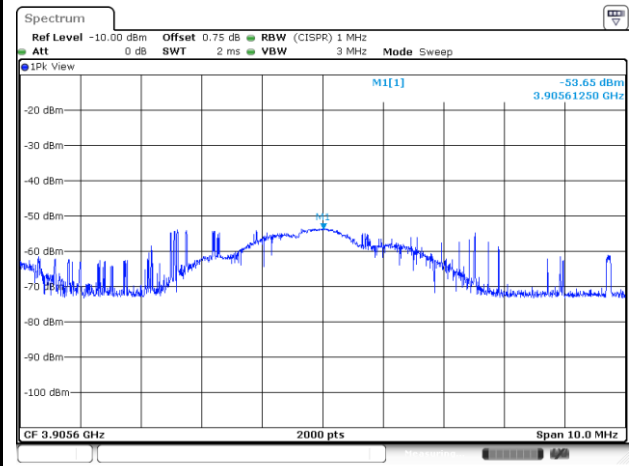
2402MHz - PK



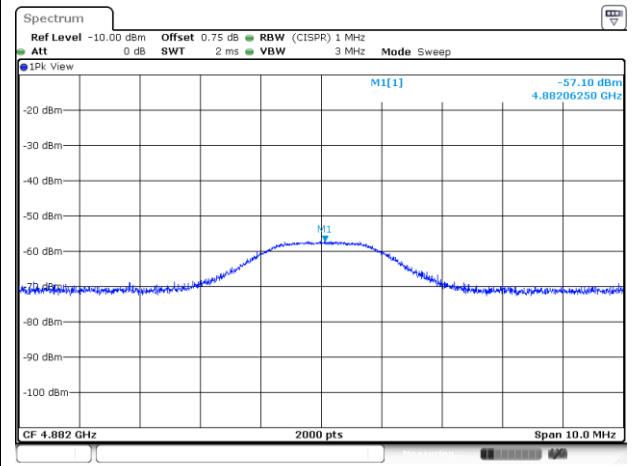
2402MHz - PK



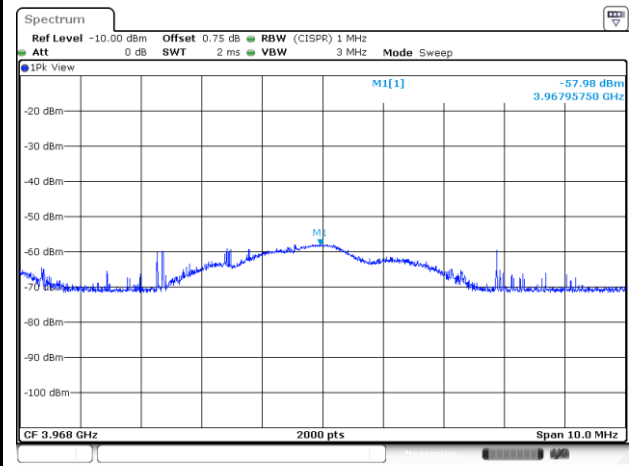
2441MHz - PK



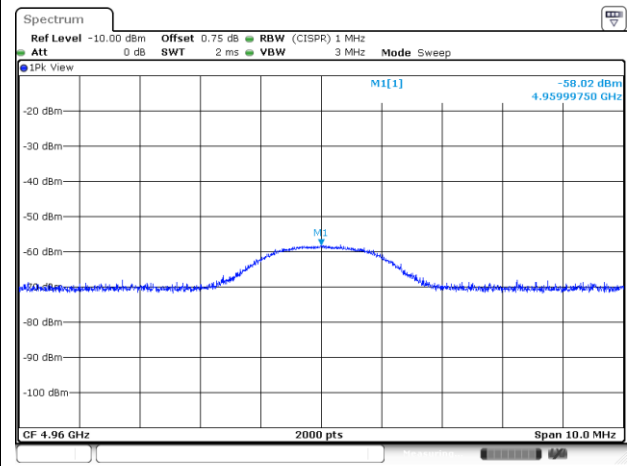
2441MHz - PK



2480MHz - PK



2480MHz - PK

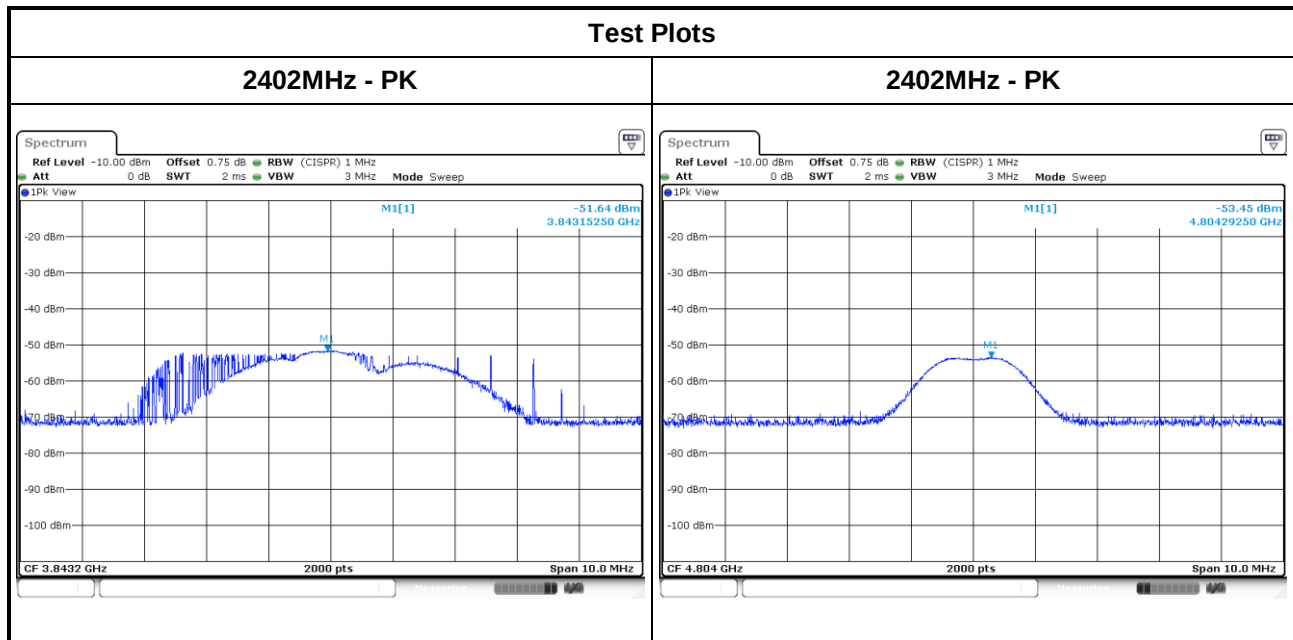


Configuration 3

Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		GFSK		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3843.20	PK	-51.64	2.79	-48.85	46.41	74.00	-27.59
4804.00	PK	-53.45	2.79	-50.66	44.60	74.00	-29.40

Note:

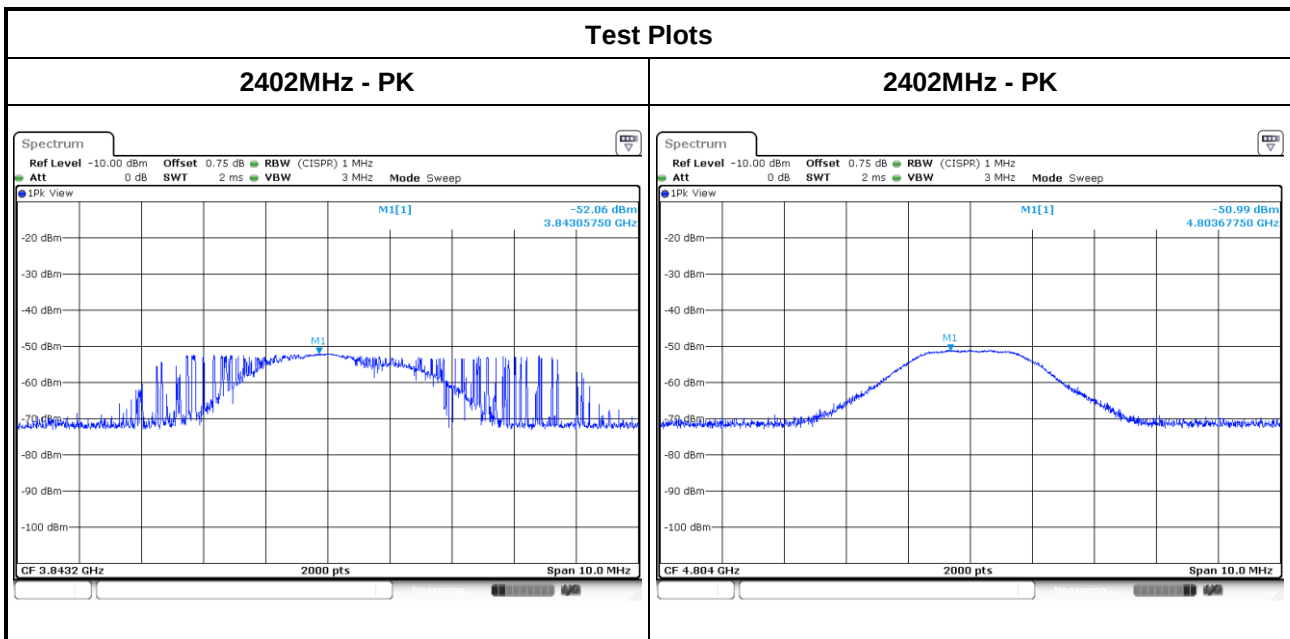
1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.



Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode		8DPSK		Frequency		2402MHz	
Freq. (MHz)	Remark	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
3843.20	PK	-52.06	2.79	-49.27	45.99	74.00	-28.01
4804.00	PK	-50.99	2.79	-48.20	47.06	74.00	-26.94

Note:

1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.



3.3 Unwanted Emissions into Non-Restricted Frequency Bands

3.3.1 Limit of Unwanted Emissions into Non-Restricted Frequency Bands

Peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz.

3.3.2 Test Procedures

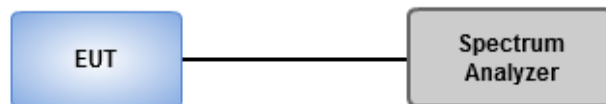
Reference level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Use the peak marker function to determine the maximum PSD level

Emission level measurement

1. Set RBW=100kHz, VBW = 300kHz , Detector = Peak, Sweep time = Auto
2. Trace = max hold , Allow Trace to fully stabilize
3. Scan Frequency range is up to 25GHz
4. Use the peak marker function to determine the maximum amplitude level

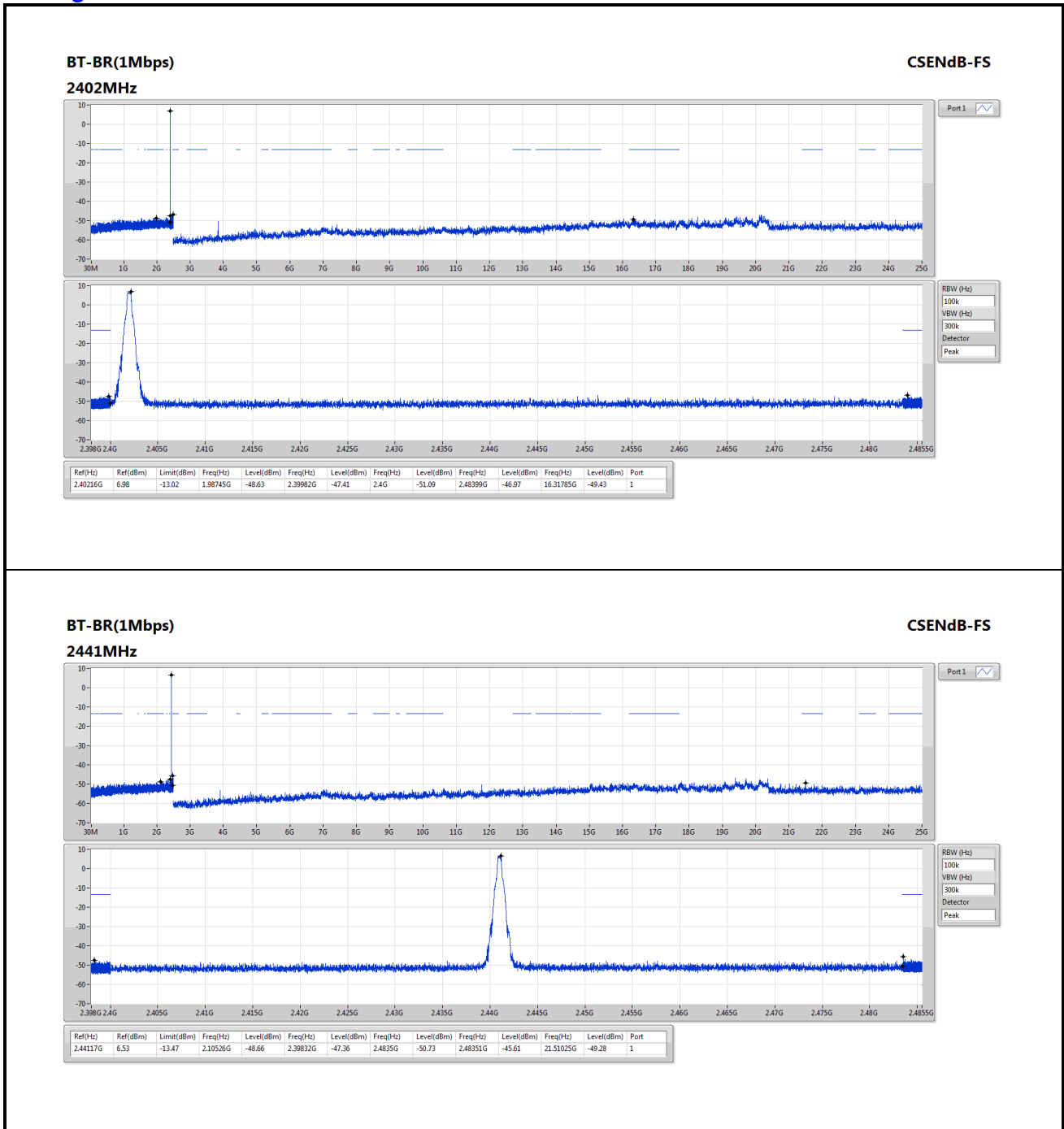
3.3.3 Test Setup



3.3.4 Unwanted Emissions into Non-Restricted Frequency Bands

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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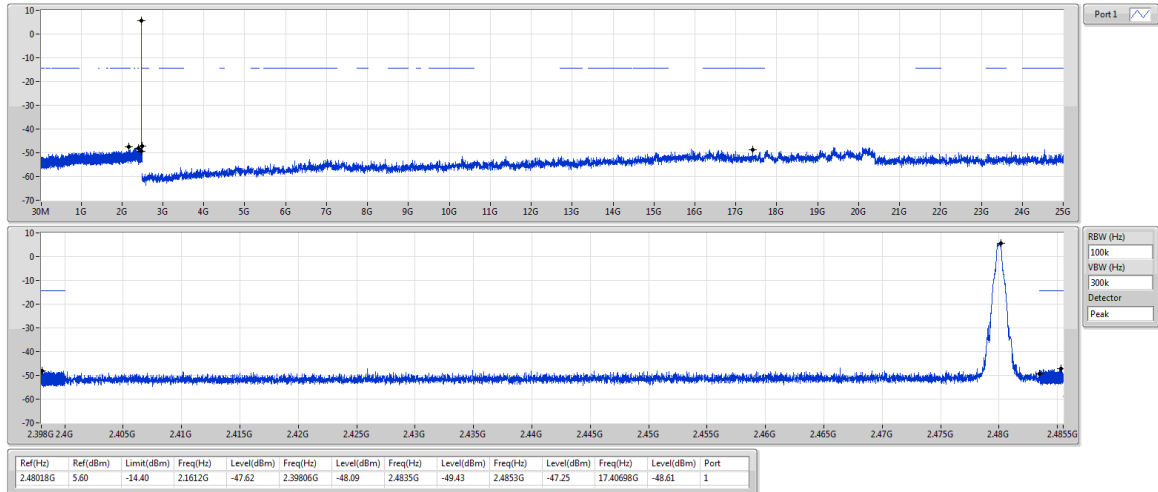
Configuration 1



BT-BR(1Mbps)

CSENdB-F5

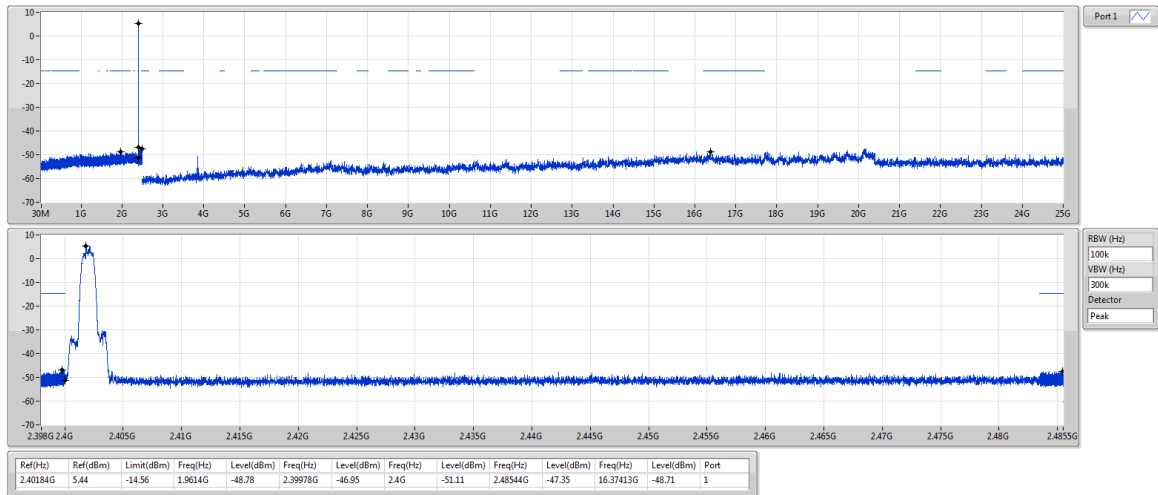
2480MHz



BT-EDR(2Mbps)

CSENdB-F5

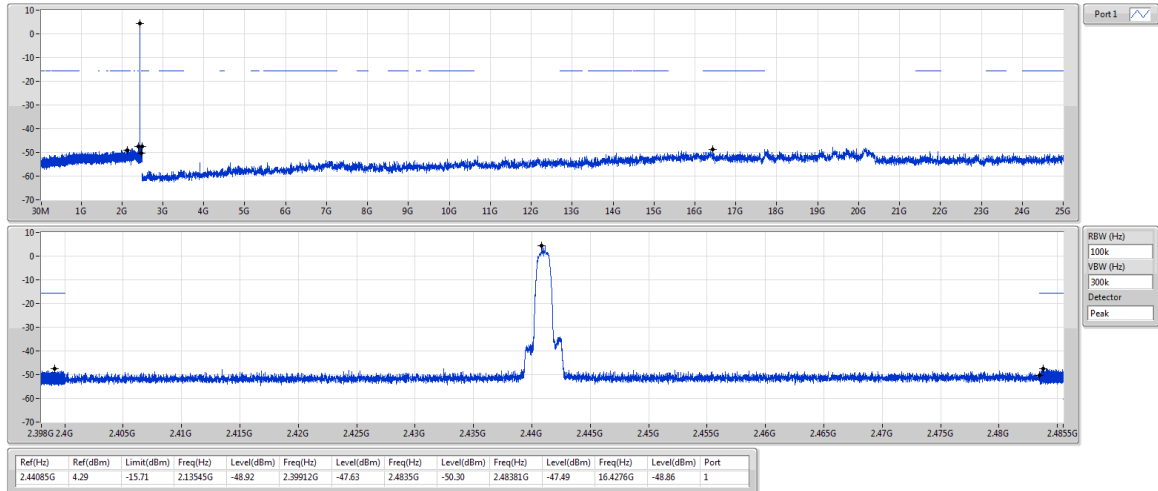
2402MHz



BT-EDR(2Mbps)

CSENdB-F5

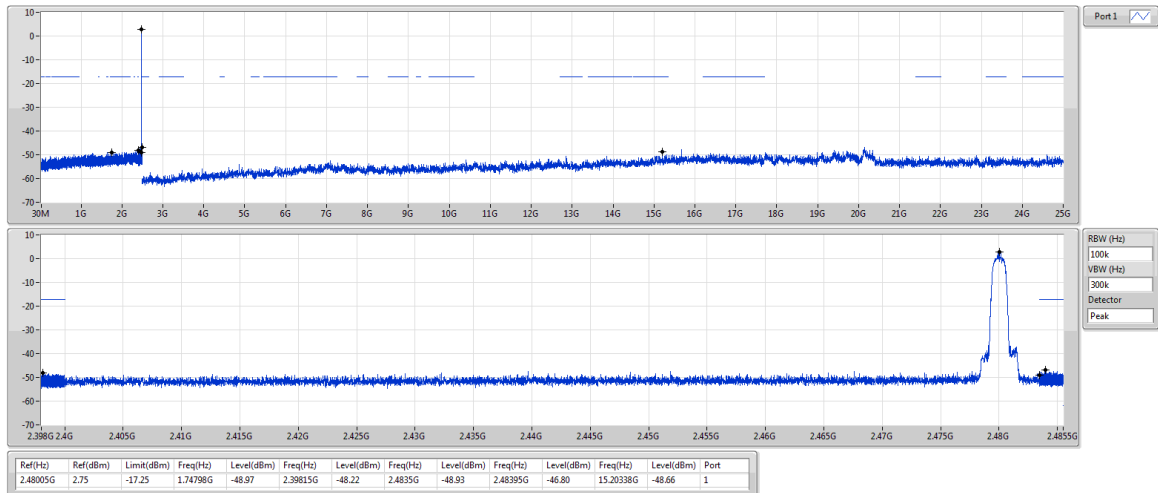
2441MHz



BT-EDR(2Mbps)

CSENdB-F5

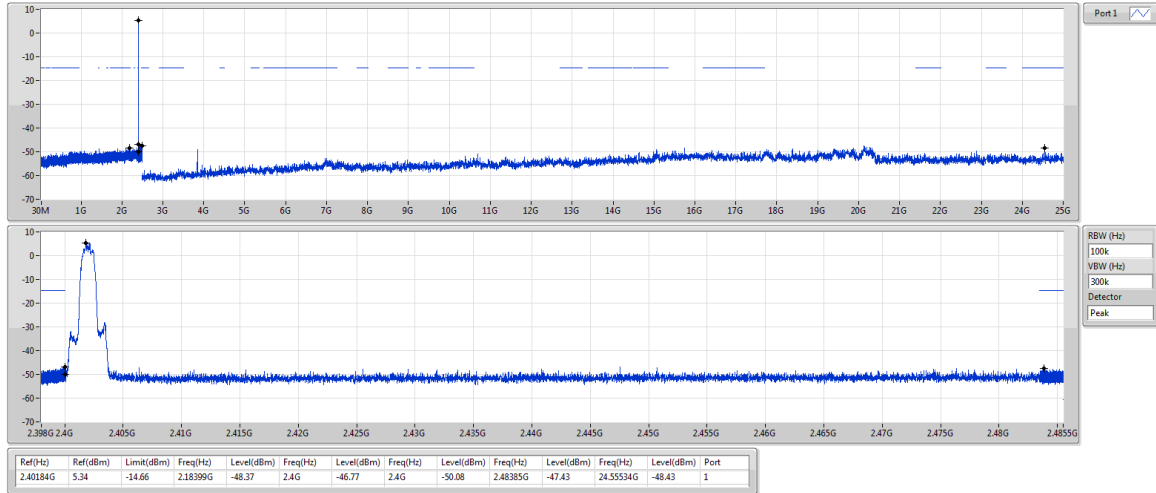
2480MHz



BT-EDR(3Mbps)

CSENdB-F5

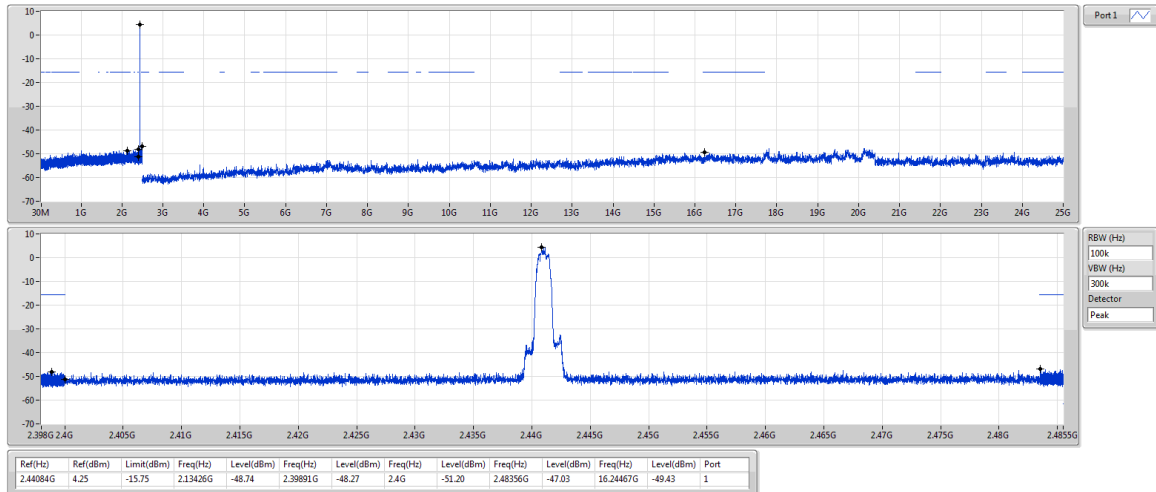
2402MHz



BT-EDR(3Mbps)

CSENdB-F5

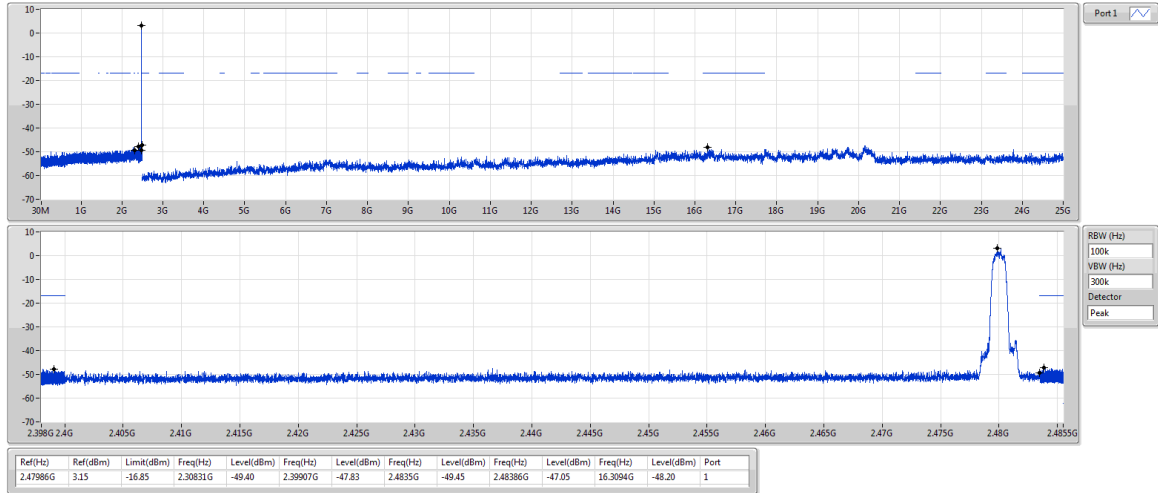
2441MHz



BT-EDR(3Mbps)

CSEndB-FS

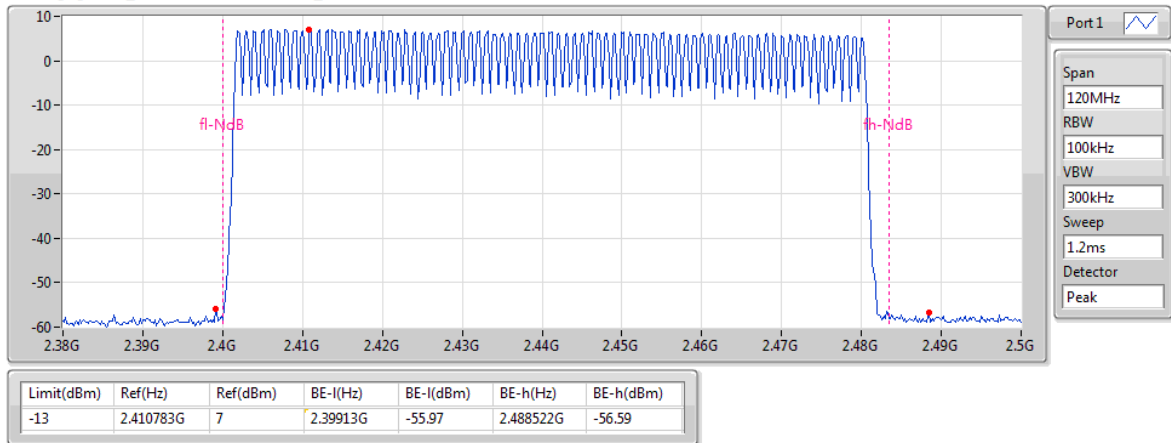
2480MHz



BT-BR(1Mbps)

2441MHz

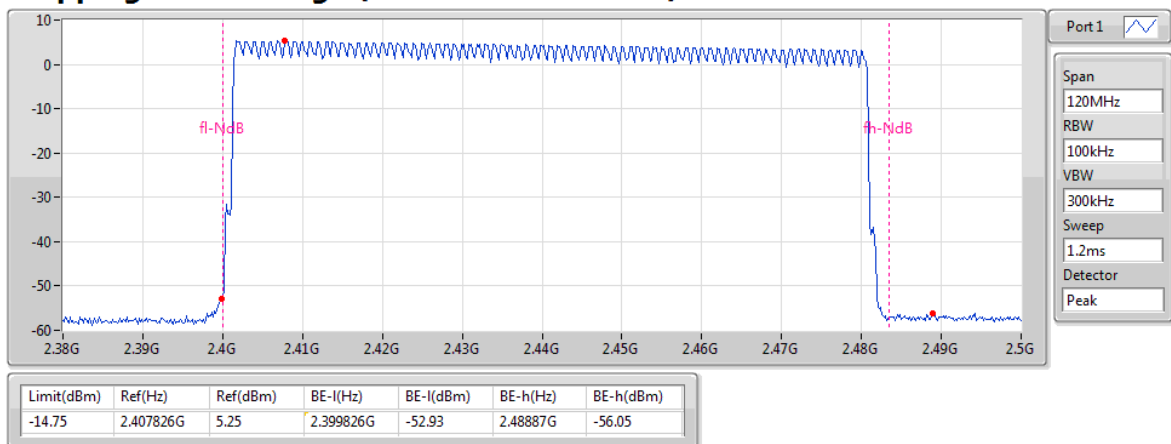
Hopping Ch Bandedge (Non-restricted Band)



BT-EDR(2Mbps)

2441MHz

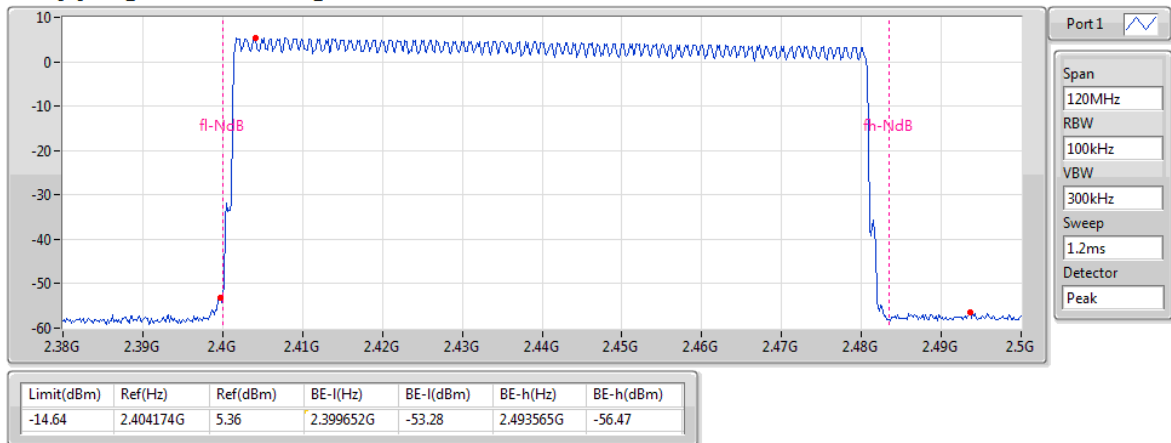
Hopping Ch Bandedge (Non-restricted Band)



BT-EDR(3Mbps)

2441MHz

Hopping Ch Bandedge (Non-restricted Band)

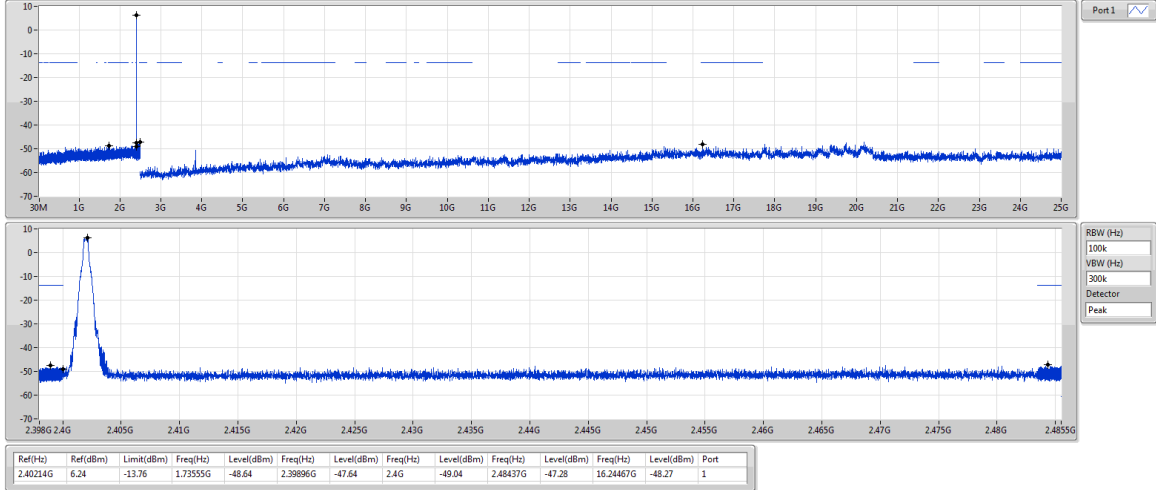


Configuration 3

BT-BR(1Mbps)

CSENdB-FS

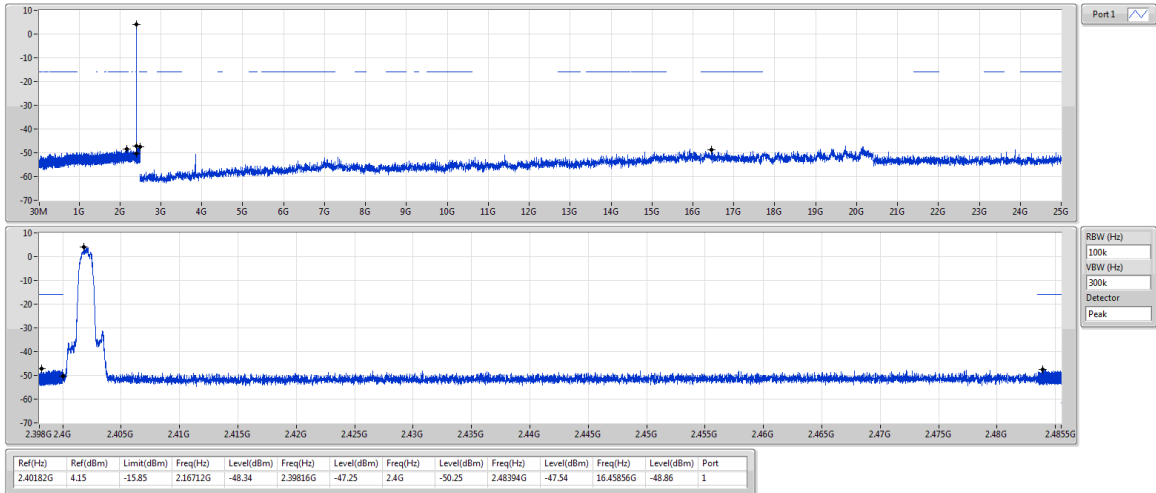
2402MHz



BT-EDR(3Mbps)

CSENdB-FS

2402MHz



3.4 Conducted Output Power

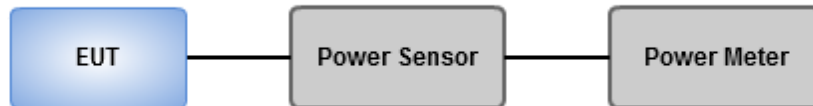
3.4.1 Limit of Conducted Output Power

- ☐ 1 Watt
For frequency hopping systems operating in the 2400–2483.5 MHz band employing at least 75 non overlapping hopping channels, and all frequency hopping systems in the 5725–5850 MHz band.
- ☒ 0.125 Watt
For all other frequency hopping systems in the 2400–2483.5 MHz band.
- ☐ 0.125 Watt
For Frequency hopping systems operating in the 2400–2483.5 MHz band have hopping channel carrier frequencies that are separated by two-thirds of the 20 dB bandwidth of the hopping channel.

3.4.2 Test Procedures

1. A wideband power meter is used for power measurement. Bandwidth of power sensor and meter is 50MHz
2. If duty cycle of test signal is not 100 %, trigger and gating function of power meter will be enabled to capture transmission burst for measuring output power

3.4.3 Test Setup



3.4.4 Test Result of Conducted Output Power

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Configuration 1

Summary of Peak Conducted Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	7.66	0.00583
BT-EDR(2Mbps)	8.49	0.00706
BT-EDR(3Mbps)	8.83	0.00764

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	2.79	7.66	21.00
2441MHz	Pass	2.79	7.26	21.00
2480MHz	Pass	2.79	6.49	21.00
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	2.79	8.49	21.00
2441MHz	Pass	2.79	7.62	21.00
2480MHz	Pass	2.79	6.46	21.00
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	2.79	8.83	21.00
2441MHz	Pass	2.79	7.94	21.00
2480MHz	Pass	2.79	6.78	21.00

Summary of Conducted (Average) Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	7.52	0.00565
BT-EDR(2Mbps)	6.25	0.00422
BT-EDR(3Mbps)	6.26	0.00423

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	2.79	7.52	-
2441MHz	Pass	2.79	7.12	-
2480MHz	Pass	2.79	6.34	-
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	2.79	6.25	-
2441MHz	Pass	2.79	5.18	-
2480MHz	Pass	2.79	3.88	-
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	2.79	6.26	-
2441MHz	Pass	2.79	5.19	-
2480MHz	Pass	2.79	3.89	-

Note: Average power is for reference only.

Configuration 3

Summary of Peak Conducted Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	6.64	0.00461
BT-EDR(2Mbps)	6.57	0.00454
BT-EDR(3Mbps)	6.92	0.00492

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	2.79	6.64	21.00
2441MHz	Pass	2.79	6.13	21.00
2480MHz	Pass	2.79	5.23	21.00
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	2.79	6.57	21.00
2441MHz	Pass	2.79	5.42	21.00
2480MHz	Pass	2.79	4.08	21.00
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	2.79	6.92	21.00
2441MHz	Pass	2.79	5.94	21.00
2480MHz	Pass	2.79	4.60	21.00

Summary of Conducted (Average) Output Power

Mode	Power (dBm)	Power (W)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	6.48	0.00445
BT-EDR(2Mbps)	4.14	0.00259
BT-EDR(3Mbps)	4.13	0.00259

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power Limit (dBm)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	2.79	6.48	-
2441MHz	Pass	2.79	5.92	-
2480MHz	Pass	2.79	5.02	-
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	2.79	4.14	-
2441MHz	Pass	2.79	2.95	-
2480MHz	Pass	2.79	1.51	-
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	2.79	4.13	-
2441MHz	Pass	2.79	2.95	-
2480MHz	Pass	2.79	1.51	-

Note: Average power is for reference only.

3.5 Number of Hopping Frequency

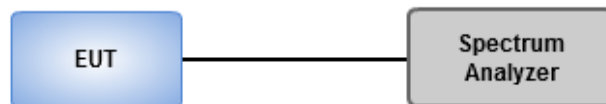
3.5.1 Limit of Number of Hopping Frequency

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

3.5.2 Test Procedures

1. Set RBW = 100kHz, VBW = 300kHz, Sweep time = Auto, Detector = Peak Trace max hold.
2. Allow trace to stabilize.

3.5.3 Test Setup



3.5.4 Test Result of Number of Hopping Frequency

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Configuration 1

Summary

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-BR(1Mbps)	79
BT-EDR(2Mbps)	79
BT-EDR(3Mbps)	79

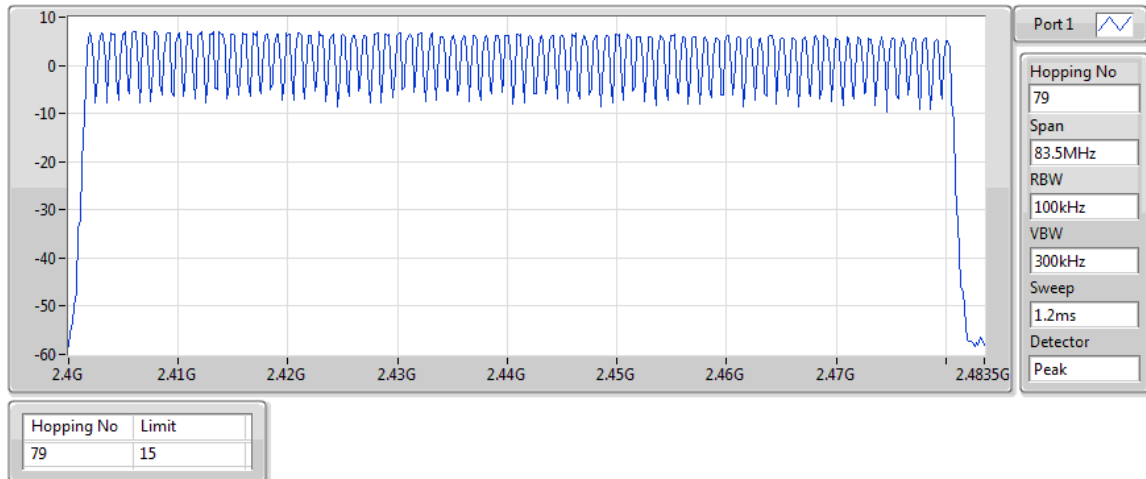
Result

Mode	Result	Hopping No	Limit
BT-BR(1Mbps)	-	-	-
2441MHz	Pass	79	15
BT-EDR(2Mbps)	-	-	-
2441MHz	Pass	79	15
BT-EDR(3Mbps)	-	-	-
2441MHz	Pass	79	15

BT-BR(1Mbps)

2441MHz

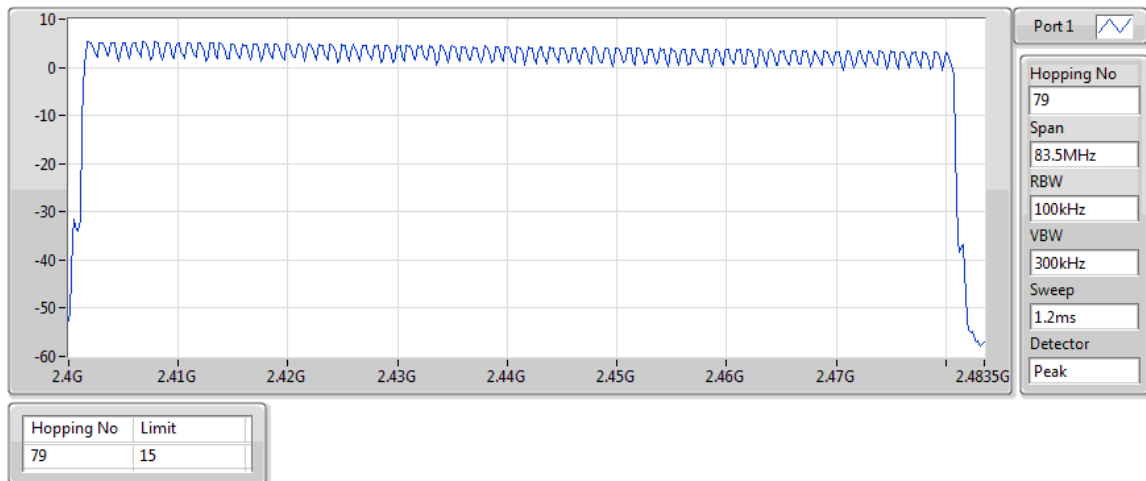
Hopping Ch



BT-EDR(2Mbps)

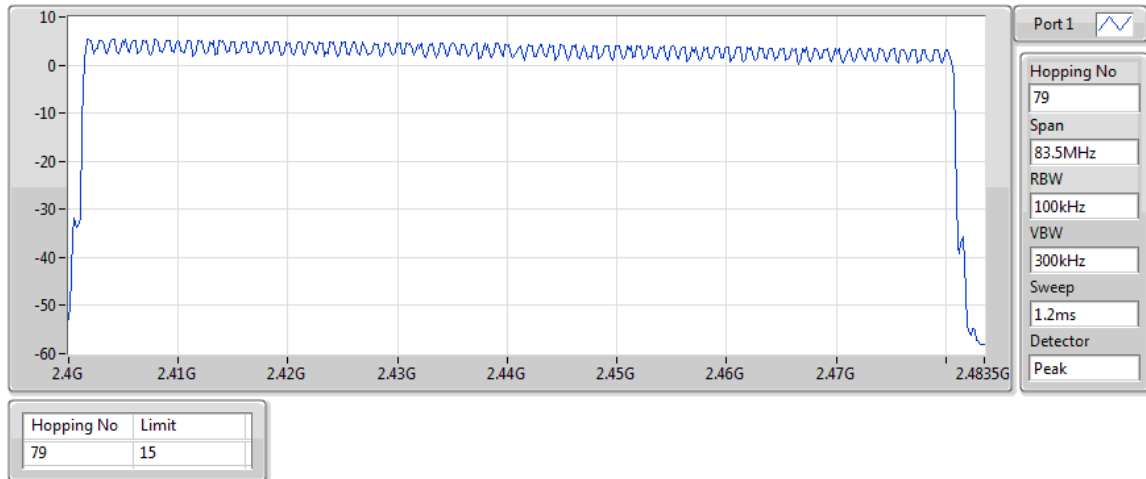
2441MHz

Hopping Ch



BT-EDR(3Mbps)
2441MHz

Hopping Ch



3.6 20dB and Occupied Bandwidth

3.6.1 Test Procedures

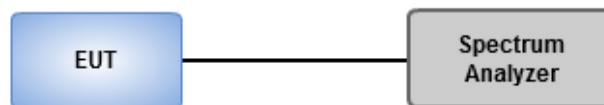
20dB Bandwidth

1. Set RBW=10kHz VBW= 30kHz for BT BR mode, RBW=20kHz, VBW=100kHz for other modes, Sweep time = Auto, Detector=Peak , Trace max hold
2. Allow trace to stabilize
3. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20 dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth

1. Set RBW=10kHz VBW= 30kHz for BT BR mode, RBW=20kHz, VBW=100kHz for other modes, Sweep time = Auto, Detector=Sample , Trace max hold
2. Allow trace to stabilize
3. Use Occupied bandwidth function of spectrum analyzer to measuring 99% occupied bandwidth

3.6.2 Test Setup



3.6.3 Test result of 20dB and Occupied Bandwidth

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Configuration 1

Summary

Mode	Max-N dB (Hz)	Max-OBW (Hz)	ITU-Code	Min-N dB (Hz)	Min-OBW (Hz)
2.4-2.4835GHz	-	-	-	-	-
BT-BR(1Mbps)	931.159k	874.096k	874KF1D	855.072k	856.729k
BT-EDR(2Mbps)	1.333M	1.21M	1M21G1D	1.312M	1.201M
BT-EDR(3Mbps)	1.348M	1.221M	1M22G1D	1.29M	1.213M

Max-N dB = Maximum 20dB down bandwidth; **Max-OBW** = Maximum 99% occupied bandwidth;

Min-N dB = Minimum 20dB down bandwidth; **Min-OBW** = Minimum 99% occupied bandwidth;

Result

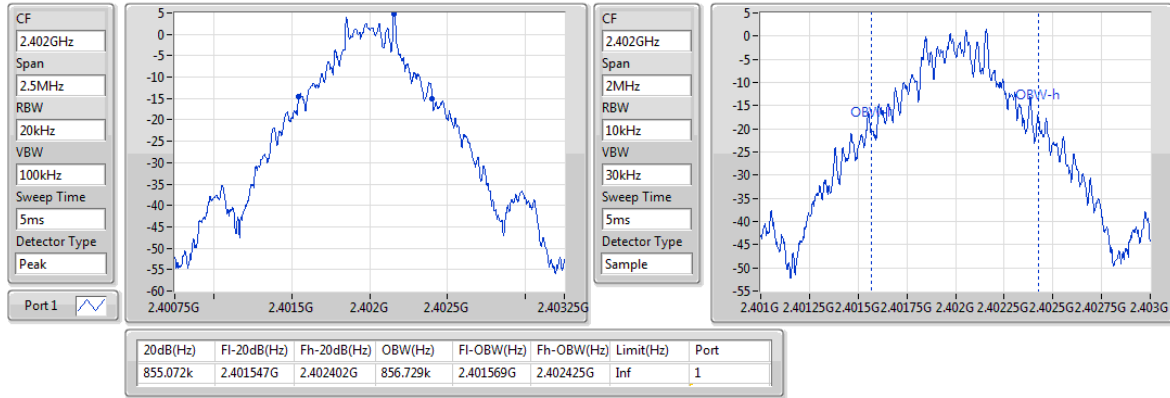
Mode	Result	Limit (Hz)	Port 1-N dB (Hz)	Port 1-OBW (Hz)
BT-BR(1Mbps)	-	-	-	-
2402MHz	Pass	Inf	855.072k	856.729k
2441MHz	Pass	Inf	923.913k	874.096k
2480MHz	Pass	Inf	931.159k	856.729k
BT-EDR(2Mbps)	-	-	-	-
2402MHz	Pass	Inf	1.312M	1.21M
2441MHz	Pass	Inf	1.333M	1.201M
2480MHz	Pass	Inf	1.319M	1.207M
BT-EDR(3Mbps)	-	-	-	-
2402MHz	Pass	Inf	1.348M	1.216M
2441MHz	Pass	Inf	1.293M	1.221M
2480MHz	Pass	Inf	1.29M	1.213M

Port X-N dB = Port X 20dB down bandwidth; **Port X-OBW** = Port X 99% occupied bandwidth;

BT-BR(1Mbps)

EBW-FS

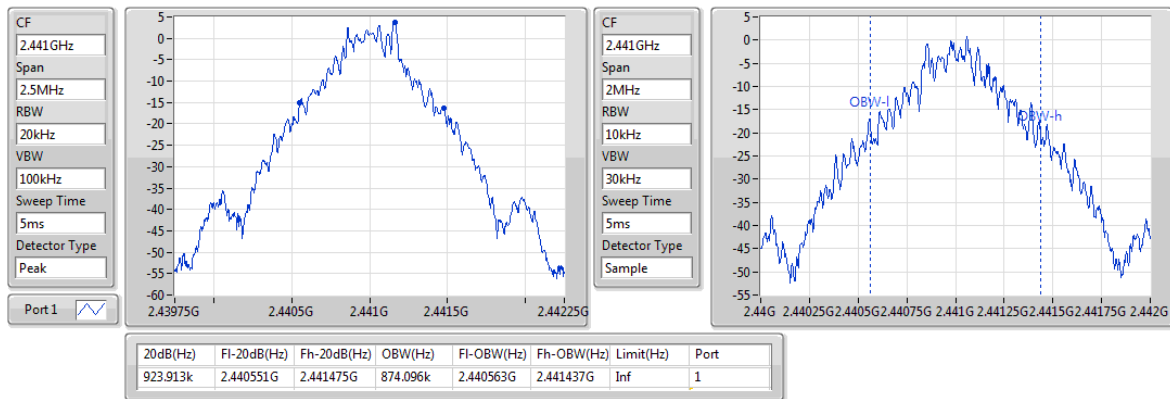
2402MHz



BT-BR(1Mbps)

EBW-FS

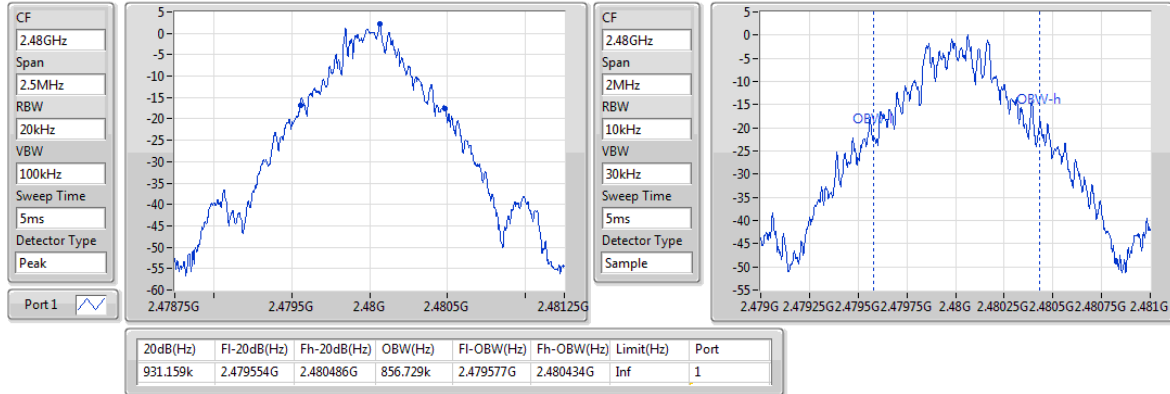
2441MHz



BT-BR(1Mbps)

EBW-FS

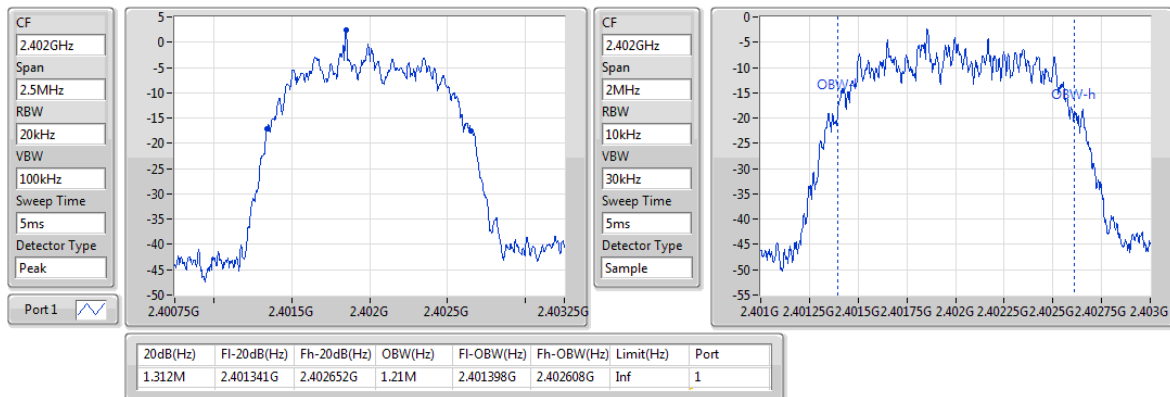
2480MHz



BT-EDR(2Mbps)

EBW-FS

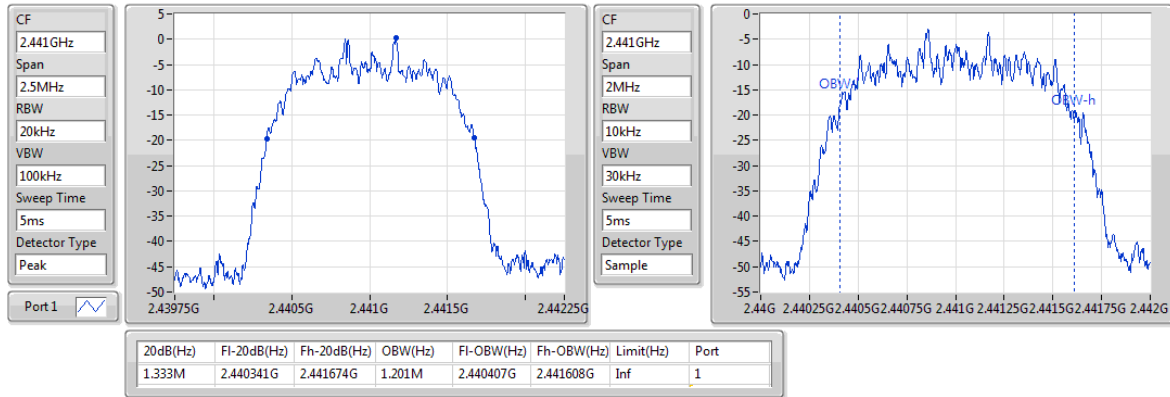
2402MHz



BT-EDR(2Mbps)

EBW-FS

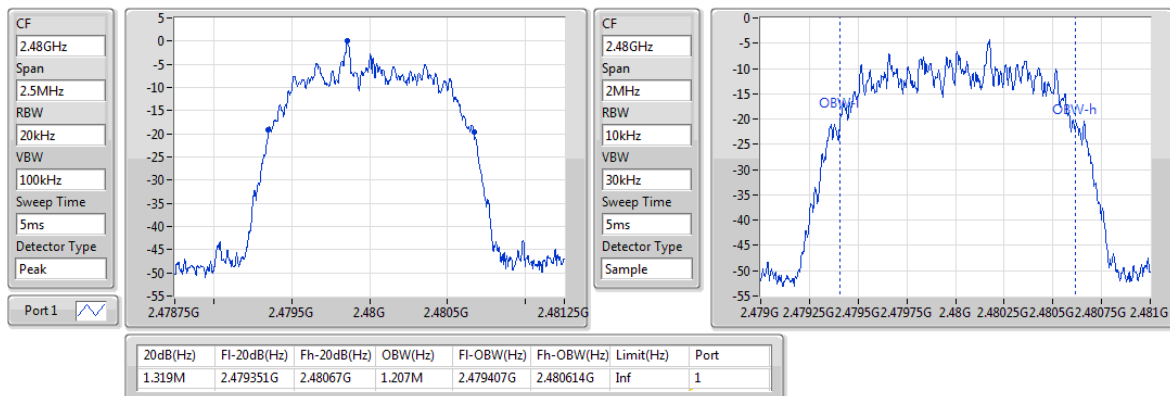
2441MHz



BT-EDR(2Mbps)

EBW-FS

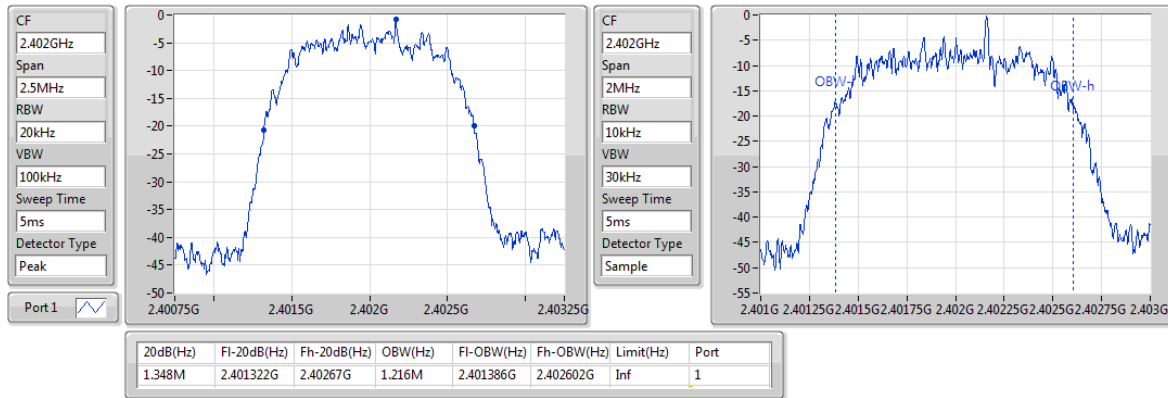
2480MHz



BT-EDR(3Mbps)

EBW-FS

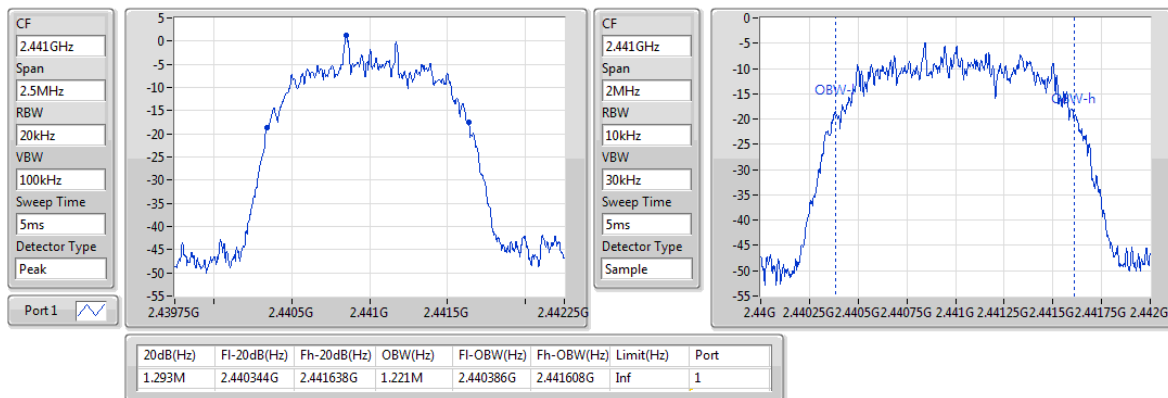
2402MHz



BT-EDR(3Mbps)

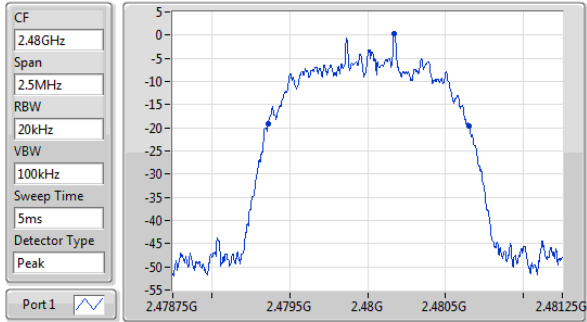
EBW-FS

2441MHz

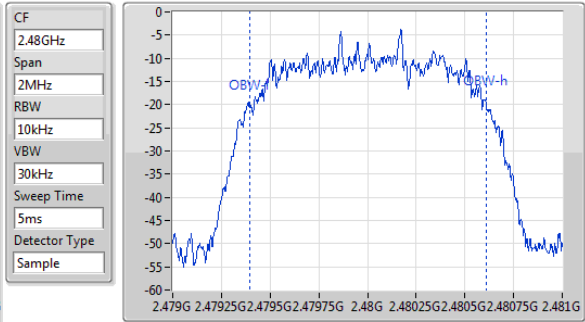


BT-EDR(3Mbps)

2480MHz



EBW-FS



20dB(Hz)	Fl-20dB(Hz)	Fh-20dB(Hz)	OBW(Hz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(Hz)	Port
1.29M	2.479362G	2.480652G	1.213M	2.479395G	2.480608G	Inf	1

3.7 Channel Separation

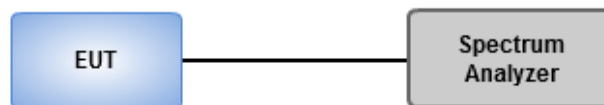
3.7.1 Limit of Channel Separation

- ☐ Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
- ☒ Frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

3.7.2 Test Procedures

1. Set RBW=30kHz, VBW=100kHz, Sweep time = Auto, Detector=Peak Trace max hold
2. Allow trace to stabilize
3. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The EUT shall show compliance with the appropriate regulatory limit

3.7.3 Test Setup



3.7.4 Test result of Channel Separation

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Configuration 1 Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-BR(1Mbps)	1M	1M
BT-EDR(2Mbps)	1M	1M
BT-EDR(3Mbps)	1.004348M	1M

Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-BR(1Mbps)	-	-	-	-	-
2402MHz	Pass	2.402157G	2.403157G	1M	569.477952k
2441MHz	Pass	2.441161G	2.442161G	1M	615.326058k
2480MHz	Pass	2.479165G	2.480165G	1M	620.151894k
BT-EDR(2Mbps)	-	-	-	-	-
2402MHz	Pass	2.401848G	2.402848G	1M	873.792k
2441MHz	Pass	2.440852G	2.441852G	1M	887.778k
2480MHz	Pass	2.478857G	2.479857G	1M	878.454k
BT-EDR(3Mbps)	-	-	-	-	-
2402MHz	Pass	2.402157G	2.403161G	1.004348M	897.768k
2441MHz	Pass	2.441161G	2.442165G	1.004348M	861.138k
2480MHz	Pass	2.479165G	2.480165G	1M	859.14k

BT-BR(1Mbps)

Channel Separation

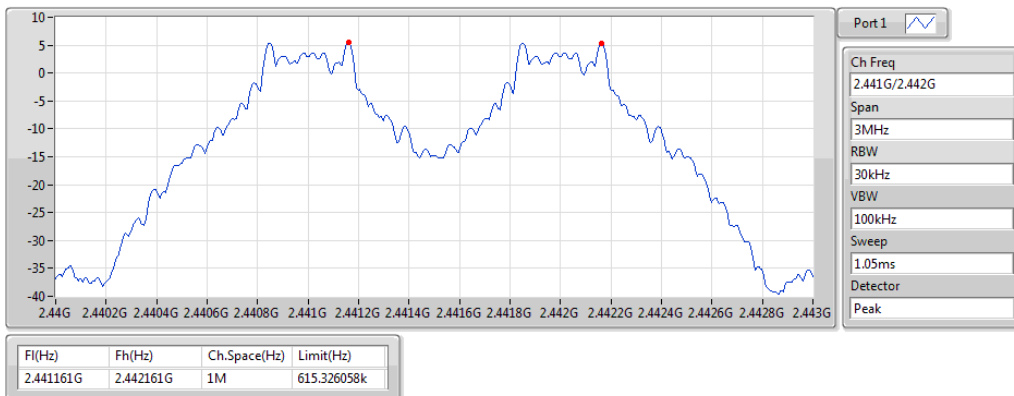
2.402G/2.403GHz



BT-BR(1Mbps)

Channel Separation

2.441G/2.442GHz



BT-BR(1Mbps)

Channel Separation

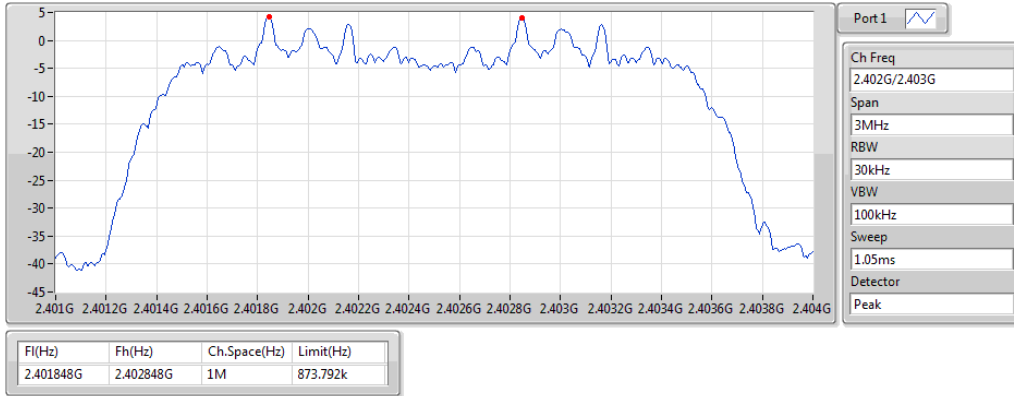
2.48G/2.479GHz



BT-EDR(2Mbps)

Channel Separation

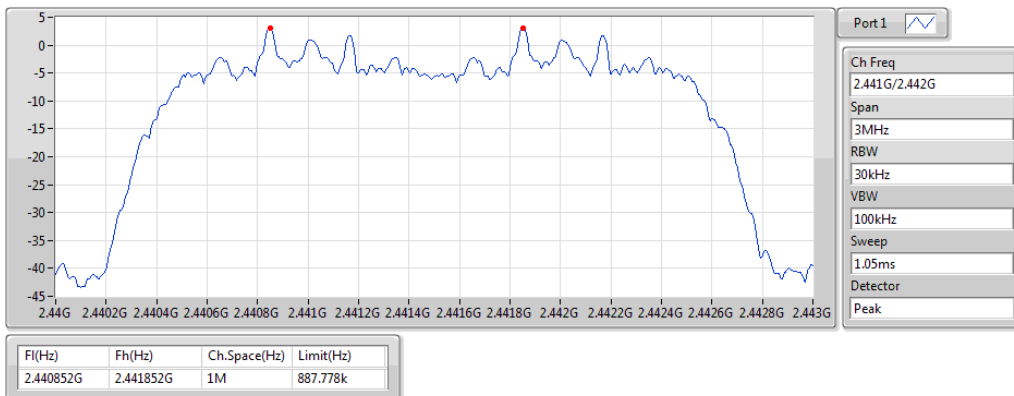
2.402G/2.403GHz



BT-EDR(2Mbps)

Channel Separation

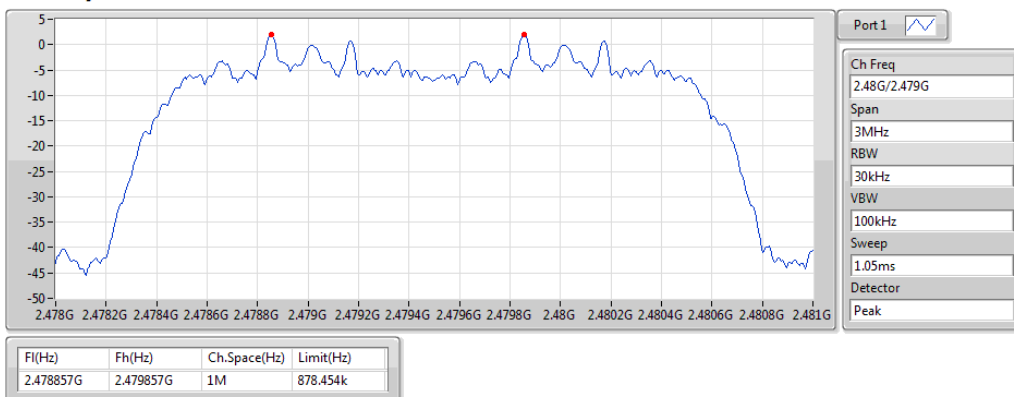
2.441G/2.442GHz



BT-EDR(2Mbps)

Channel Separation

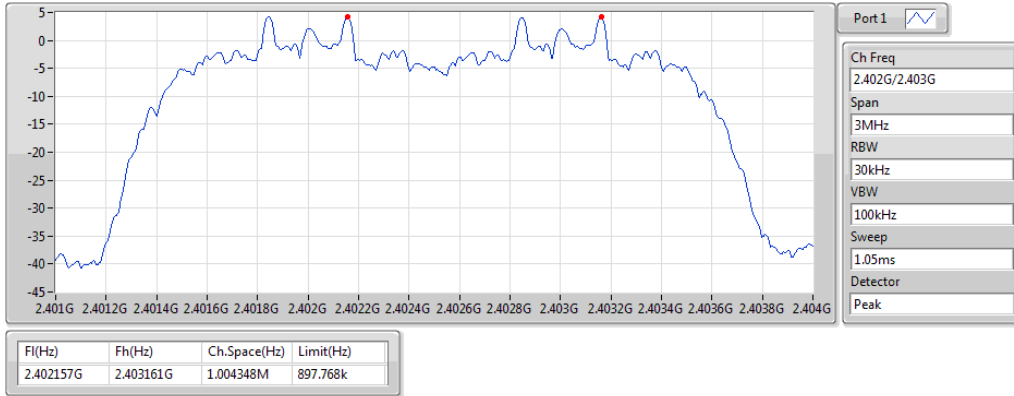
2.48G/2.479GHz



BT-EDR(3Mbps)

Channel Separation

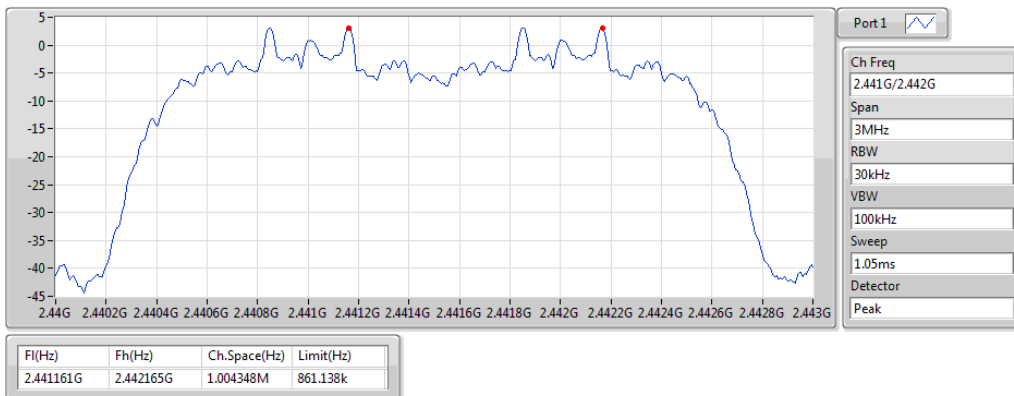
2.402G/2.403GHz



BT-EDR(3Mbps)

Channel Separation

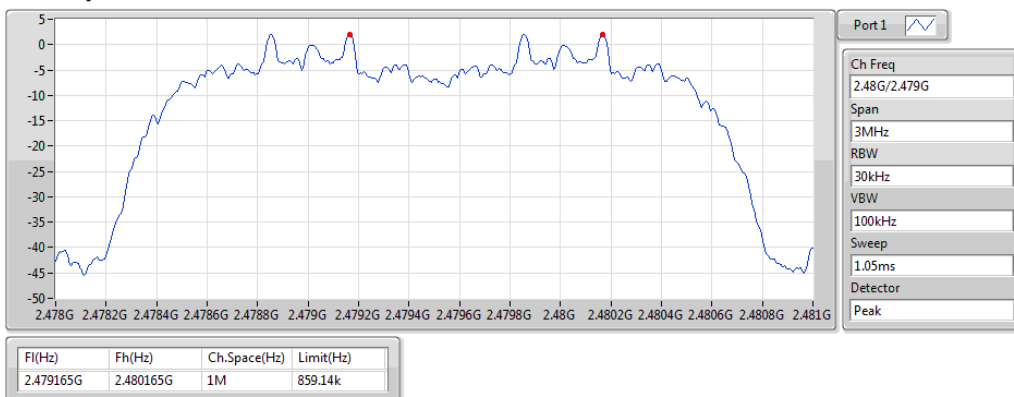
2.441G/2.442GHz



BT-EDR(3Mbps)

Channel Separation

2.48G/2.479GHz



3.8 Number of Dwell Time

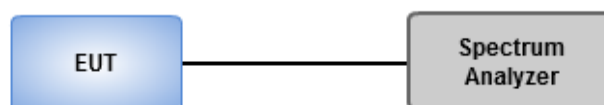
3.8.1 Limit of Dwell time

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

3.8.2 Test Procedures

1. Set RBW=300kHz,VBW=1MHz,Sweep time = 10 ms, Detector=Peak, Span=0Hz,Trace max hold
2. Enable gating and trigger function of spectrum analyzer to measure burst on time.
3. The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slots.
Non AFH mode
The hopping rate is 1600 hops/second so the maximum dwell time is 1/1600 seconds. DH1 Packet permit maximum $1600 / 79 / 2 = 10.12$ hops per second in each channel (1 time slot TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $10.12 \times 31.6 = 320$ within 31.6 seconds.
AFH mode
The hopping rate is 800 hops/second so the maximum dwell time is 1/800 seconds. DH1 Packet permit maximum $800 / 20 / 2 = 20$ hops per second in each channel (1 time slot TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $20 \times 8 = 160$ within 8 seconds.
4. The DH3 packet can cover up to 3 time slots. A maximum length packet has duration of 3 time slots.
Non AFH mode
The hopping rate is 1600 hops/second so the maximum dwell time is 3/1600 seconds. DH3 Packet permit maximum $1600 / 79 / 4 = 5.06$ hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $5.06 \times 31.6 = 160$ within 31.6 seconds.
AFH mode
The hopping rate is 800hops/second so the maximum dwell time is 3/800 seconds. DH3 Packet permit maximum $800 / 20 / 4 = 10$ hops per second in each channel (3 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $10 \times 8 = 80$ within 8 seconds.
5. The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and maximum duty cycle. A maximum length packet has duration of 5 time slots.
Non AFH mode
The hopping rate is 1600 hops/second so the maximum dwell time is 5/1600 seconds, or 3.125ms. DH5 Packet permit maximum $1600 / 79 / 6 = 3.37$ hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $3.37 \times 31.6 = 106.6$ within 31.6 seconds
AFH mode
The hopping rate is 800 hops/second so the maximum dwell time is 5/800 seconds. DH5 Packet permit maximum $800 / 20 / 6 = 6.667$ hops per second in each channel (5 time slots TX, 1 time slot RX). So, the dwell time is the time duration of the pulse times $6.667 \times 8 = 53.33$ within 8 seconds

3.8.3 Test Setup



3.8.4 Test Result of Dwell Time

Ambient Condition	25°C / 67%	Tested By	Aska Huang
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Result

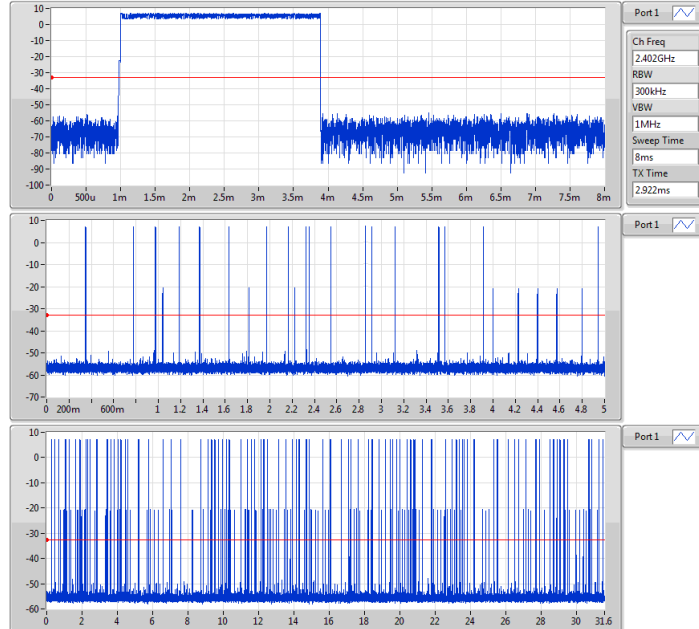
Result/ Non AFH mode						
Mode	Result	Period (s)	Dwell (s)	Limit (s)	Tx On (ms)	Number of transmission in a 5 s
BT-BR(1Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	31.6	0.33241	0.4	2.92200	18
BT-EDR(2Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	31.6	0.31418	0.4	2.92425	17
BT-EDR(3Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	31.6	0.35156	0.4	2.92775	19
Note 1: Dwell time =Number of transmission in a 5 second x Tx On Time x 6.32						
Note 2: DH5 was the worst mode.						

Result/ AFH mode						
Mode	Result	Period (s)	Dwell (s)	Limit (s)	Tx On (ms)	Number of transmission in a 2 s
BT-BR-AFH(1Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	8	0.31544	0.4	2.92075	27
BT-EDR-AFH(2Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	8	0.30399	0.4	2.92300	26
BT-EDR-AFH(3Mbps)	-	-	-	-	-	-
2402MHz_DH5	PASS	8	0.31590	0.4	2.92500	27
Note 1: Dwell time =Number of transmission in a 2 second x Tx On Time x 4						
Note 2: DH5 was the worst mode.						

BT-BR(1Mbps)

Dwell

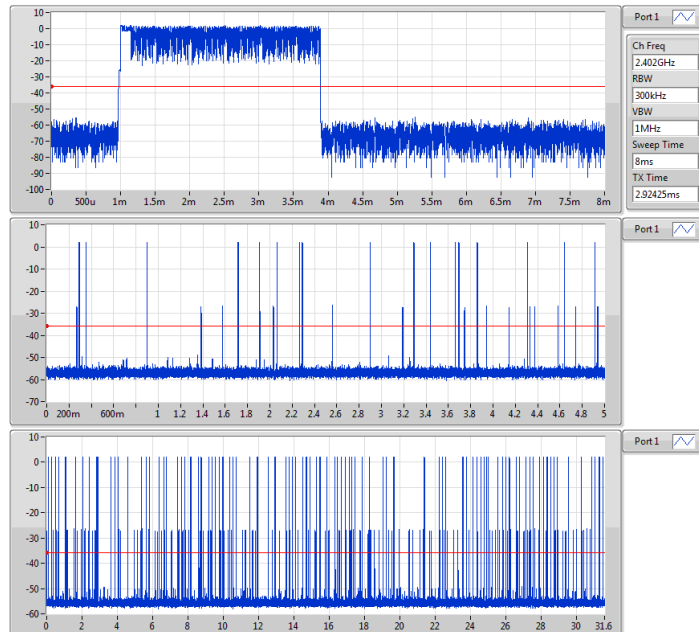
2402MHz



BT-EDR(2Mbps)

Dwell

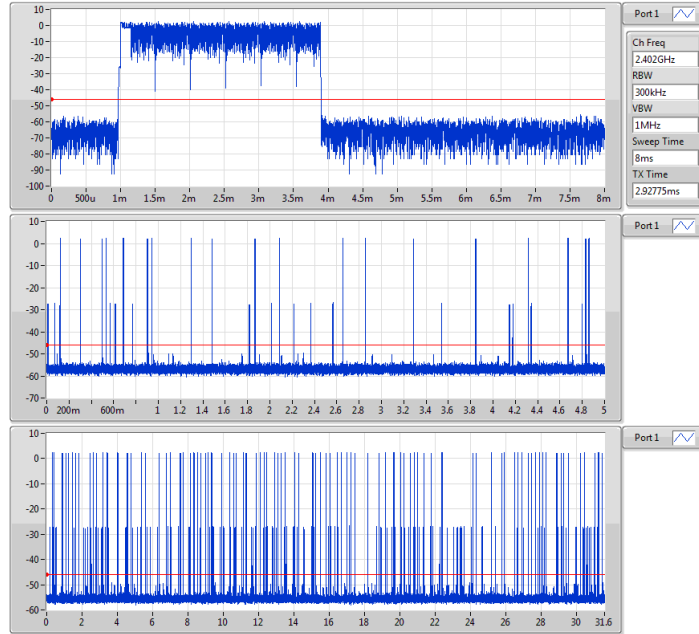
2402MHz



BT-EDR(3Mbps)

Dwell

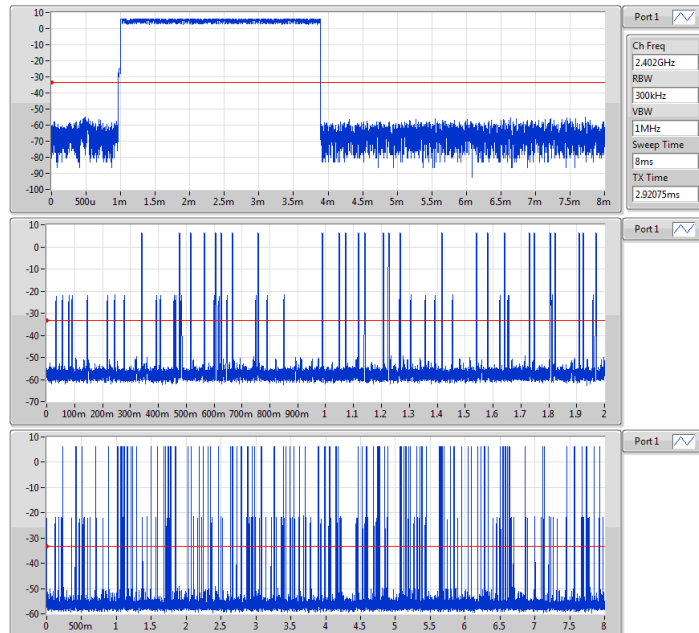
2402MHz



BT-BR-AFH(1Mbps)

Dwell

2402MHz



BT-EDR-AFH(2Mbps)

Dwell

2402MHz



BT-EDR-AFH(3Mbps)

Dwell

2402MHz



4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

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Kou District, New Taipei City,
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Kwei Shan

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Kwei Shan District, Tao Yuan City
333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd
St., Kwei Shan District, Tao Yuan
City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information.

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Fax: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

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